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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

DECEMBER 14.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Chromium Plating," Paper by L. Wright, B.Sc.

Institution of Mechanical Engineers:—Ordinary meeting in London. "Machinability," Paper by E. G. Herbert, B.Sc.

West of Scotland Iron and Steel Institute:—Ordinary meeting at Glasgow. Commercial Paper by Professor W. R. Scott, M.A.

Society of Chemical Industry (Chemical Engineering Group):—Ordinary meeting in London. "The Air-lift as a Chemical Engineering Appliance," Paper by Norman Swindin.

Institute of British Foundrymen.

DECEMBER 15.

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. "Blacking, Coal Dust, and Light Castings," Paper by J. M. Primrose.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "The Application of the Microscope to the Study of Metals and Alloys," Paper by G. Mohn, M.Sc.

Newcastle and District Branch:—Ordinary meeting at Neville Hall. "The Production of Malleable Castings," Paper by F. H. Hurren.

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. "The 'Safety First' Movement in Foundries."

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "Refractory Materials," Paper by W. R. D. Jones.

DECEMBER 21.

Sheffield Branch:—Ordinary meeting at Sheffield. "General Aspects of Die Casting," Paper by T. F. Russell.

Obsolescence.

It is, of course, a well-established principle in business practice that such fixed assets as buildings, plant, equipment, etc., shall be depreciated at a definite rate per annum, on the basis of writing off the whole of the original cost of such assets by the time that their replacement becomes necessary. Further, it is recognised that such replacement is not always rendered necessary by sheer wear; the end of the allotted period frequently finds some of the equipment still in quite good condition. What is provided for is not so much wear as obsolescence. Assets of this type may be rendered completely out of date, and hence useless, as a result of changes and developments of one sort and another—a shortage of labour or a dearth of a particular raw material, an innovation in industrial practice or a change in the nature or the scope of public demand.

It has recently been pointed out—not for the first time—that fixed capital is not the only portion of the assets of a given business to suffer from obsolescence, and that in fact the possibility of *knowledge* becoming obsolete is real and serious.

Our existing knowledge, after all, is capital of the most vital description; neither money nor the things it can buy are of any use without brains to direct them, nor can the finest works in the world run themselves.

And this knowledge-capital suffers like the other kinds from depreciation. It depreciates as every fresh discovery and new idea leaves it behind, out of date, out of line with current practice. To a very large extent our present industrial difficulties in this country have arisen because we, who were once undisputed industrial leaders of the world, have allowed other countries to outdistance us in the application of brains to business and so render our knowledge-capital obsolete.

The idea of research expenditure—expenditure, that is, on the extension and development of knowledge—as a form of insurance against the depreciation of this invisible capital, is not a new one. It has now been extended on the parallel of the depreciation of fixed assets referred to above. The value of existing knowledge never appears on either side of the balance-sheet, although in fact it is a very real asset to the business, and its depreciation is a very real liability. Now if this depreciation were represented on one side of the balance-sheet as the depreciation of fixed capital is in fact represented, it would be balanced on the other side by the acquisition of new knowledge through research expenditure.

Unfortunately, what happens is that neither the value of knowledge nor its depreciation figure appear on the balance-sheet at all, so that the research expenditure appears as a kind of extra. Hence a good many of the objections raised against it as an extravagance.

It must be borne in mind that the invisible is not necessarily the non-existent, and that in this case the invisible has a very real and important existence. If this were generally appreciated, it is possible that expenditure on research might be a little more willing and lavish than is customary in certain quarters, and our industrial rivals might have to look to their laurels in earnest.

Extending.

From time to time engineering establishments add a foundry department to their organisation, and, more rarely, a foundry reverses the order of things and installs a machine shop. We are particularly pleased when the latter course is taken, because it results in the creation of a concern of a *more natural order*, and one having greater sympathy towards our great amorphous industry. Now, under the conditions operating to-day it is often a little difficult to build machine shops as a department of a foundry concern, but, as a general business proposition, we suggest that where possible steps should be taken to do more than to supply raw castings.

It is desirable to make arrangements with an engineering works whereby machined castings can be supplied to customers ready for incorporating into their machines or engines, the business being effected on a system of the sub-division of profits at a predetermined ratio. In one case where this has been achieved the founder is receiving a pound a ton more for his castings than previously. In another case some unmachined malleable castings supplied to a railway company carried 25 per cent. of machine-shop wasters. The foundry received permission to supply machined castings, and this loss was quickly reduced to 2 per cent., owing to increased facilities for co-operation.

There is a very elementary lesson, which many founders have still to learn, and that is, the nearer they can get to the finished article the better the chance of securing reasonable profits.

It should be clearly understood that many foundry departments of large engineering firms are extremely well run, and staffed by an enlightened management, which is recognised by the directorate as an essential entity in the general organisation. These are a credit to industry, but a few others merely utilise their foundry department as means to ensure the regular supply of castings, at a speed more rapid, and a cost lower than quoted by the most insignificant hole-and-corner concern in the district. This precludes any real chance being accorded to the foundry for rational expansion and technical progress.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The International Tin Position.

To the Editor of The Foundry Trade Journal.

Sir,—Is New York supplanting London as the world's real commercial centre? Since the establishment of the Ministry of Commerce in the U.S.A. the world's markets have been converging on the American capital, and now comes the news, the significance of which the British business world seems singularly slow in appreciating, that in order to free itself from the domination of the London Metal Market, a National Metal Exchange has been opened in New York.

That the opening of the new exchange will be a good thing for the tin producer—it is to deal primarily in tin, we are told—as well as for the American merchant, no one who studies the question will doubt, but surely it is an anomaly that the price of a metal, nearly half of which is produced within the British Empire, and over four-fifths of which is smelted within the British Empire, should be settled, not in London, the capital of the Empire, but in New York, the capital of a rival, if friendly, country. For that is what the new exchange, if it be a success, really means.

Is it not time that our people woke up to what is happening, and, recognising that there is a serious danger that London before long may become a back number, took steps to prevent its supersession?—Yours, etc., William Lunn.

House of Commons, December 8.

Diesel Locomotives.

Messrs. William Beardmore & Company, Limited, Glasgow, are building a number of modified Diesel engines for a new type of oil-burning locomotive, driven by a combination of Diesel engine and electric dynamo, which has been introduced in Canada by the Canadian National Railways. It is a development of the self-propelled oil-electric car used in Canada and Britain because of its economy in operation. An interesting feature of the new engine is a water boiler which acts as an exhaust silencer, and at the same time as a central-heating plant for the train. The locomotive is in two units, each fitted with a twelve cylinder Diesel engine 12-in. bore and 12-in. stroke. The complete engine weighs approximately 650,000 lbs. and is capable of hauling a train of 2,800 tons at an average speed of 40 miles per hr. It carries 16,000 lbs. of fuel oil, 22,000 lbs of water, 6,000 lbs. of sand and 2,000 lbs. of lubricating oil—sufficient for a 12-hrs'. run.

New Locomotive Construction Work for Derby.

In these days of more or less industrial depression and when big foreign foundry contracts are few, English founders are ever watchful for orders and ready to promote schemes for increased employment. Of course, there are some who are really busy, but there are other works which are fairly quiet. Good news, however, has come to Derby, and from inquiries made by our representative it is understood that plans are at present under consideration which will give a valuable stimulus to employment at the local L.M.S. works and in which foundry labour will receive its fair share. The plans, our representative learns, are for a new monster express locomotive, which it is believed will surpass in power and speed every existing type in the country. The plans, which are at present under consideration, are said to be of rather a sensational character. They have been under the personal consideration of Sir Henry Fowler, the chief mechanical engineer of the L.M.S. at Derby. The strictest secrecy, however, is being kept with regard to the preparations for the introduction of the new locomotive.

If everything proceeds satisfactorily, and there is no reason for one to think otherwise, then there should be much employment created by the construction of a series of giant locomotives. Already Derby can claim the distinction of having produced many types of famous locomotives. Whether, and if so, these new plans are to be proceeded with Sir Henry Fowler will decide shortly.

Some years ago a remarkable design for a super-Pacific four-cylinder engine was completed at Horwich, near Bolton, and another at the L.M.S. centre. When Sir Henry Fowler became chief mechanical engineer these plans were brought to Derby, and it is suggested that the present engine is based to a certain extent on the Horwich plans. It is, however believed that these plans have been modified and altered into a six-coupled, superheated high-pressure express locomotive, which, if constructed, would be the most powerful in the country. Sir Henry has long been an ardent advocate of the compounding principle, and it would not be surprising, therefore, if the new engine turned out to be a monster compound—the first of its kind to be built in this country. One thing is certain, and that is the working steam pressure of the new engine is one of the highest ever employed for a passenger engine. However, owing to the strict secrecy that is being observed, very few details of the design are known.

Cementation of Steel by Special Manganese Alloys.

A Paper was read recently before the Académie des Sciences, by M. J. Cournot, who has studied the subject of cementation of carbon steels by means of manganese-base alloys. The investigation covered ordinary mild, semi-hard and hard steels, while the substances mainly used for cementation were the following iron alloys, in a state of fine powders:—(1) Ordinary spiegel, containing 15.42 per cent. Mn and 4.16 per cent. C.; (2) ferro-manganese, rich in Mn (76.19 per cent.) and a carbon content of 6.52 per cent.; (3) a ferro-alloy containing 19.25 per cent. Mn, 20.64 per cent. Si, and 10.34 per cent. Al.

The factors studied were:—(1) The composition of the carburising mixture; (2) temperature and duration of cementation; (3) initial nature of the steel; (4) nature of the carburising medium; and (5) the rate at which the carburising mixture was used up in the course of successive cementations. The testing included hardness and corrosion tests and the preparation of micrographs.

The best effect was obtained by adding to the cementation medium about 2.5 per cent. each NH_4Cl and Al (by weight). Mixtures of spiegel with Caron's medium, without NH_4Cl or Al, were also studied, in the proportions by weight of 94.5 to 6.5, 89 to 11, and 78.5 to 21.5.

Cementation with spiegel (without Caron's medium) gave a penetration similar in appearance to that of ordinary cementation with carbon, but diffusion was a little slower; very fair thicknesses, of pure eutectoid appearance, were thus obtained, without carbide in the case.

Rich ferro-manganese gave a similar but retarded diffusion. Moreover, there appeared, when temperatures above a certain minimum were employed, a thin external white coat, which was highly resistant to attack. The thickness of the coating was about 0.05 mm., after heating at 1,150 deg. C. for four hours. An increase in the carbon content of the samples slowed down the eutectoid diffusion, and also caused the white coat obtained with rich ferro-manganese to appear at a lower temperature. The higher the carbon content, the lower was the temperature at which the white coating appeared.

Spiegel (without Caron's medium) gave, at the same temperature and equal period of heating, results somewhat superior to carbon; also much greater uniformity was obtained, and the soft spots often found were reduced in number. The results obtained with spiegel mixed with Caron's medium were poor. It was found, on carrying out successive cementations with ordinary spiegel-carburising mixture without reconditioning, that the cementation effect dropped rapidly.

With regard to corrosion resistance, it was found that test pieces of mild steel subjected to cementation for 4 hrs. at 1,000 deg. C. with the FeMn-SiAl alloy were rapidly attacked when immersed in dilute (10 per cent.) sulphuric, nitric and hydrochloric acids and in concentrated HCl. Attack by pure concentrated sulphuric and nitric acids was, however, slow.

Random Shots.

Quite a lot of comment has been made in the Press lately about steel sleepers, and the advantage that would accrue to the British steel industry if they were adopted as railway standards. I cannot quite follow an argument which on the one hand wants the railways to be efficient and businesslike, reduce fares, and increase privileges, and on the other wants to tie them to special materials which may not necessarily be economic.

* * *

The sleeper question, however, is rapidly becoming an economic one. The wooden sleeper appears to be about the same price as a steel sleeper, and as a consequence the latter is coming into service. A ton of steel makes about fourteen sleepers at a cost of about £11. The railway companies have been experimenting for some years, and the Southern has placed an order for 70,000, representing about 35 miles of track.

* * *

Founders, of course, are primarily interested in the chair, for in the steel sleeper the chair is cast as an integral part of the sleeper, so that no fastenings are required. Evidently the coming of the steel sleeper will place a great advantage in the hands of those firms which have their own steel plant, just as in the past those firms owning blast furnaces have had an advantage through ready access to pig-iron.

* * *

The main enemy to be met in the case of the steel sleeper would seem to be rust. The material used for ballast is by no means neutral and the conditions would favour corrosion unless some sort of surface protection is offered. In any case, however, there would be a service life of many years.

* * *

There is a very old Fleet Street story of an elderly lady who, pleased with the sympathetic understanding and mature outlook on life expressed by "Aunt Penelope" of some popular weekly, called in person to express her thanks. "Aunt Penelope" used to occupy the last page of the paper, and gave all kinds of advice on etiquette, nursery and household topics, and on love, courtship and marriage. The visitor was directed to a very pert young man, engaged, with his feet on the mantelpiece, in smoking Woodbines and reading the "Pink 'Un"!

* * *

I suspect that something of the same kind would happen if you went into the offices of half a dozen newspapers. You would find those amiable people who write the daily gossip column. They so skilfully manage to give the impression that they really take part in the life of the exalted circles in which they move, that the reader cannot help but feel that they are just snappers up of unconsidered trifles.

* * *

I suppose that the reader is largely to blame for the existence of the gossip writers, and I must say that no country in the world does it so well; not even America, with its complete lack of privacy in ordinary life, manages to give such depth to the superficialities of social life. If the average member of the public is really interested in the artistic aspirations of Lady Drayhorse, or the talents as host and wit of the Duke Deadhead, then the public certainly gets what it asks for.

* * *

I mentioned some time ago that when I went to Blackpool I met Albert. I found him on the pier putting coins of the realm in the slot of a machine which he pressed vigorously, and occasionally he was rewarded by the machine disgorging coins into a cup. Albert said the machine offered him all the joys of stock exchange speculation for a very small risk. Albert is by way of being a character as well as a foundry foreman. His doings may from time to time be amusing.

* * *

New Alphabet for Ironfounders—continued.

X is Xceedingly trying to rhyme:
And Y is for Youth, that dislikes overtime:
While Z in this game is a positive crime!"

"Marksman."

Herrn. Bardenheuer and Zehen Answer Critics.

In discussing the technical literature cited in Part I of our Paper, Mr. Shaw states that if no graphite is found in cast iron which is run in a thin stream into water, this is no proof of the direct segregation of graphite from the melt. The experiments quoted were not made for the purpose of providing such proof, but, on the contrary, were intended only to show that the graphite in the cast iron is dissolved with sufficient rapidity only at a high temperature, and that the beneficial effect of superheating the metal on the finer formation of the graphite is to be sought in the complete dissolution of the graphite residues present in the melt (P. Bardenheuer: "Der Graphit im grauen Gusseisen," Mitt. K.W.-Inst. Eisenforsch., 9 (1927), p. 219; "Stahl und Eisen," 47 (1927), p. 861).

Mr. Shaw further states that free graphite is seldom absent in cupola iron, owing to the short melting time and the relatively low temperature, and that the ultimate structure of such metal is dependent to some extent upon the size of the graphite already present in the charge. This, he states, provides a logical answer to the question of "Why semi-steel of the same composition as a pig-iron has nearly always a finer graphitic structure?" On this point it must be observed that in semi-steel a finer graphitic formation is obtained owing to the fact that in the low-carbon alloy the graphite residues are more easily dissolved. The high melting temperature necessary owing to the large steel addition employed is also an important contributory factor.

In Part II of our Paper Mr. Shaw finds in every series of experiments a reduction of carbon content accompanying increased superheating. He attributes this to oxidation or to our having possibly diluted the melt, and remarks that the greatest breaks in the curves from time to time appear when the crucible material has been changed. In reply we have to state that in this series of experiments the question we set ourselves was: "Does the tendency to undercooling increase continuously with an increasing heating temperature, or is there a maximum temperature above which the formation of graphite again increases?" The direction of the influence of superheating can be seen unmistakably from our experiments. From the vacuum melts in particular there is a continuously increasing tendency to carbide solidification in the centre of the test bars accompanying a rising temperature. As a result of nucleation of the crucible wall a partial abatement in the undercooling certainly then sets in again at the edge of the test bar, and in the melts with air admission the bars solidify partly white and partly grey after high superheat temperatures, owing to nucleation caused by released gases. The photo-micrographs alone, however, should suffice to show these results. The carbon loss from oxidation or reaction with the crucible material (in no case was there any dilution of the material with steel) was unavoidable, but in any case it has nothing to do with the answer to the questions mentioned above. We have given the carbon analyses merely for the sake of completeness. The change in the crucible material no doubt alters the photo-micrograph somewhat, but this change was unavoidable owing to the working conditions. It is true that the test bars in the first series of experiments and some of the superheat stages in the second series were cast below the liquidus, and therefore already contained some solid solution, but this is quite immaterial. The casting temperature of 1,200 deg. was chosen in consideration of the lowest heating stage of 1,200 deg., so that all the test pieces should be cast at the same temperature.

Dendritic Structure and Strength.

Dealing with Part III of our Paper, Mr. Shaw remarks with regard to the photo-micrographs of a certain white pig-iron (first sand-cast and then chill-cast), recently published by Bardenheuer ("Stahl und Eisen," 47, 1927, p. 860), as Figs. 3 and 4, that a glance at the photo-micrographs shows that part of the increased strength of the chilled bars is due to the size and formation of the crystals. Although both are dendritic, he states, the arrangement and small grain size of the chilled bars give a stronger formation of the ground mass. In regard to this, it may be stated that no strength investigations were carried out on the bars in question. Moreover, these bars were used only for the purpose of solving the question whether graphite can be segregated below the melting point. Apart from this, it appears to us very rash to assume as a matter of course that a chill-cast iron with elongated dendrites, as in Fig. 4, possesses better strength properties on account of the smaller size of the crystals than a sand casting with a coarser but less dendritic structure. The same thing ought to hold good in comparing annealed chill-cast iron with sand-cast iron solidified grey. In any case the influence of the grain size and arrangement of the crystals of the matrix on the mechanical properties is far from being comparable with that of the formation and distribution of the graphite.

Pearlitic Structure,

With reference to our conclusion from the 11th series of experiments, that an all-pearlitic structure can impart still greater strength even to an iron containing graphite in suitable form, Mr. Shaw inquires what is meant by an all-pearlitic structure. With a pearlitic structure, he states, one may equally well obtain a tensile strength of 9 tons as one of 20 tons. This is no doubt correct, but it is just this fact that only serves to confirm once again our conclusion that the graphite is of preponderating importance in regard to the strength of cast iron. For such differences in strength can never be attributed to a different formation of the pearlite, but only to that of the graphite.

Regarding the question as to the practical advantages of chill casting, we would reply that it was certainly not the purpose of our investigations to introduce a new process into practice. It was merely our intention to show that a refinement of the graphite, no matter how it might be effected, is of decisive importance in improving the mechanical properties of cast iron.

The favourable results obtained by us with high-silicon bars in our series of experiments led us to investigate the influence of silicon as well as other alloys on the mechanical properties of low-carbon cast iron. We hope to be able to report the results shortly.

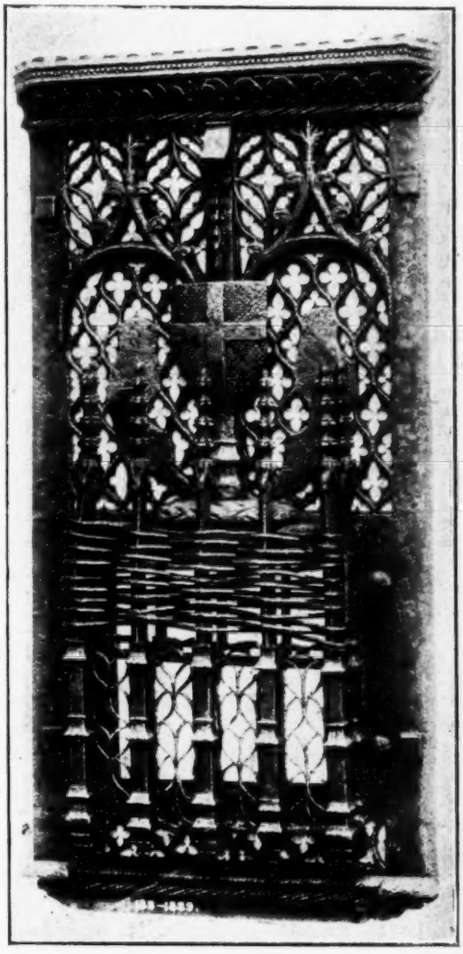
In conclusion, one further reply to the question why in Part IV of our Paper the same types of iron were not used in the different experiments, so that the results might be better compared. This portion of the work was carried out partly in the metallurgical laboratory of the Kaiser Wilhelm Institute for Iron Research and partly in different iron foundries. In our researches it was necessary to use the types of iron that happened to be available.

South African Steel Agreement.—In response to inquiries from the shareholders of the Union Steel Corporation (of South Africa), Limited, asking for further details in regard to the terms of agreement signed between that company and the South African Iron and Steel Industrial Corporation, it is announced by the Union Steel Company that the bases of the terms of agreement are as follow:—That the South African Iron and Steel Industrial Corporation will concentrate generally on the production of ordinary primary steel products, and that the Union Steel Corporation (of S.A.) shall gradually cease to be a producer of ordinary primary steel products, excepting tube steel, which they retain in order to fulfil their contract with Messrs. Stewarts & Lloyds, and both it and its subsidiary companies will confine their activities to special steels and general engineering. (2) The Union Steel Corporation (of South Africa), Limited, will continue to produce pig-iron and to run its blast furnace exactly as to-day, and there will be no limit put on its present producing capacity. In addition, it has the right to manufacture cast-iron pipes, and will continue to manufacture steel and iron castings and railway chairs. The statement of the Union Steel Corporation continues as follows:—With reference to the question of bounties, this was not discussed, as it is a question purely for the Government Department concerned. The position is that the Court of Appeal reversed the first judgment given in favour of the Corporation, and held that the Minister was justified in requiring evidence of actual production as proof of the capacity of the blast furnace. The furnace has now been put into commission again, and will be producing 50,000 tons per annum.

A Unique Double Grille.

The picture accompanying this article shows a piece of metal work which claims interest for two reasons. The first, that it takes the unusual form of a double grille; the second, that it exhibits a pattern so rare as to be probably unique. The grille proper at the back calls for no special notice, but it shows good work, both in design and craftsmanship. The smaller grille set before the larger is, however, quite another matter. The fact that it should be where it is—placed in front of the other—is remarkable, and to this is to be added the fact that the design of the upper part makes this little grille perhaps one of the most striking.

The upper part shows us a complete country wooden fence reproduced in metal. Sir Walter



AN UNUSUAL FORM OF DOUBLE GRILLE.
(By courtesy of the Director of the Victoria and Albert Museum.)

Scott's description of the stonework in Melrose Abbey is here something like an accomplished fact. Sir Walter says:—

"Then framed a spell when the work was done
And turned the willow wands to stone."

In this screen we see what is still called in country districts a "rattle fence," but here the wands are not hazel boughs woven in and out between wooden stakes, but apparently woven bars of metal! The whole work is most interesting. Such a peculiarly rustic appearance indicates clearly the very interesting and unusual fact of the design having emanated from the brain of a man very familiar with country life.

This double grille is only a very little one, being but 17 in. in height in all. It is said to have been made towards the end of the 15th century, but the flowing lines of the reticulated tracery seem to indicate a somewhat earlier date. In any case it is a singularly beautiful little piece of ironwork.

Iron-Manganese Alloys.

REPORT OF THE METALLURGICAL ADVISORY BOARD TO THE CARNEGIE INSTITUTE OF TECHNOLOGY AND THE U.S. BUREAU OF MINES.

At a meeting of the Metallurgical Advisory Board to the Carnegie Institute of Technology and the United States Bureau of Mines, held recently at Pittsburgh, Pa., Dr. V. N. Krivobok presented a Report of Research on "Iron-Manganese Alloys." The Report dealt with the preparation and constitution of alloys and the determination of specific properties and microscopic studies.

Determinations of critical points have been successful in the alloys up to and including 6.12 per cent. manganese. The results so far obtained can be briefly summarised as follows: (1) As manganese increases, the A_2 and A_3 points are gradually lowered, especially those on cooling. (2) With increasing manganese the range of critical transformations is much widened, *i.e.*, the transformation takes place over a certain range of temperatures. This finding, already reported in the publication on low-carbon manganese steels, is of considerable importance in the heat treatment of commercial manganese steels. (3) The alloy containing 6.12 per cent. manganese shows an abnormal phenomenon. The critical points on heating are approximately the same as in alloys of lower manganese, but on cooling there is a very sudden drop of A_3 point to 360-305 deg. C. and of A_2 point to 287-260 deg. C. This observation was repeated three times with the same results, and becomes especially significant when the heat treatment of this alloy is considered.

Upon heating a sample of this alloy to 950 deg. C. (1,742 deg. Fah.) or higher, the refinement of grains clearly occurs. Heating just above the determined Ac_2 point, namely, up to 890 deg. C. (1,630 deg. Fah.), produces no grain refinement. It is clear then that on heating, the transformation is very sluggish and requires a considerable overheating for the process of recrystallisation to begin. The sudden drop of critical points on cooling is of much interest and may be similar to the phenomenon observed in other steels, particularly nickel.

Carburising of Manganese Alloys.

This particular study was undertaken immediately following the investigation of iron-manganese alloys of low-manganese content used in the study of abnormality in steels. All the alloys were subjected to standard carburising treatment, namely, for eight hours at 940 deg. C. ± 11 deg. C. All the alloys containing between 6.0 and 9.30 per cent. manganese have yielded on carburisation, in general, similar results. One of them, representing alloys containing between 7.5 and 9.30 per cent. manganese, will be described as typical.

The extreme outside carburised layer consists of austenitic grains surrounded by the network of cementite and typical troostite. Immediately following this zone one finds an area of martensitic needles, possessing extreme hardness, as should be expected.

This experiment has been repeated several times, and certain conclusions can be drawn from it: (*a*) The addition of carbon to manganese-rich alloys results in the stabilisation of iron-manganese solid solution. It no longer shows the tendency toward easy decomposition along the cleavage planes into two separate phases. (*b*) The change from solid solution (austenite) into mechanical agglomerate (pearlite) does not imply the formation of martensite. The latter is not formed when the tendency for decomposition along cleavage planes is suppressed, and, consequently, the often mentioned chain of transformations—austenite, martensite, troostite—is not unreservedly correct. (*d*) It was observed, but needs further substantiation, that under certain conditions of treatment an outside layer of martensitic structure can be produced. The toughness of the 9.12 per cent. manganese alloy is preserved, but in addition hardness better than that of commercial carburising steels is easily obtained.

In alloys with lower manganese content (6.07-7.5 per cent. Mn) the outer carburised zone contains, in addition to austenite and troostite, carbidic formations, not only at the grain boundaries, but also deposited at the cleavage planes. These cleavage carbides are often surrounded by the troostitic constituents.

The alloy with 18.87 per cent. manganese and another with 17.23 per cent. manganese showed what may be termed a resistance to carburisation. Their structure and hardness remained unchanged. The numerous etching reagents applied to the alloy have failed to reveal the presence of carbides. The chemical analysis of the outside layer showed that the sample picked up only 0.037 per cent. carbon during eight hours' carburisation at 940 deg. ± 5 deg. C. As a final test a most careful weighing of the sample before and after carburisation has repeatedly shown no increase in weight, although a sample of 7.38 per cent. manganese should weigh one per cent. more after carburisation. Although this alloy was carefully investigated, this last experiment with rather unusual results will be repeated before final conclusions are definitely reached.

Mechanical Properties of the Alloys.

At the present time only small amounts of prepared alloys are available for this study, and, consequently, only the determination of hardness of alloys, both untreated and treated, is available for consideration.

There is a very definite trend toward the increase in hardness with increase in manganese, as shown in Table I.

Table I.—*Showing Composition and Hardness.*

Manganese, per cent.	Hardness Rockwell.
1.6	35—40 B. very soft.
6.12	31.0 C.
7.44	33.5 C.
9.30	43.5 C.
18.87	10.0 C.

The last alloy is decidedly softer, but a full line of alloys to determine the composition at which softening begins is not available meantime. The comparison between carbonless 9.30 per cent. manganese alloy and the one containing 9.12 per cent. manganese and 0.30 per cent. carbon shows a remarkable difference in hardness, carbonless manganese alloy being almost twice as hard as the other. This holds true not only for alloys in "as cast" condition, but also after extensive heat treatment.

On quenching, carbonless 9.30 per cent. manganese alloy shows practically no change in hardness until the quenching temperature is raised to about 2,100 deg. Fah. (1,150 deg. C.). At this temperature a perceptible softening takes place. In an alloy containing small amounts of carbon this softening occurs at lower temperature. The hardness of carbonless manganese alloys does not depend on the rate of cooling after heating.

Constituents of Alloys in Cast Conditions.

Until recently the prevailing idea was that iron and manganese formed a continuous series of solid solution. Wohrman was the first to publish a short Paper questioning this belief. The work in the Bureau of Metallurgical Research has demonstrated beyond doubt that Wohrman's conclusions are correct. Of the alloys investigated those of 6.12, 7.44, 9.30 and 18.87 per cent. manganese all showed well-developed Widmanstättian structure, seemingly made up of at least two constituents, probably of solid solution type. In the cast alloys the degree of development of the structure seems to depend on the amount of manganese; the higher the manganese content, the more clearly defined is Widmanstättian structure. One of the important studies was to solve the problem of the nature and the composition of the constituents of the Widmanstättian structures. It is quite possible that their nature is analogous to the nature of constituents found in high-nickel meteorites. As the amount of manganese increases above 1.6 per cent. the structure begins to reveal certain irregularities, which can be seen only after most careful preparation of polished sections. At 4.3 to 4.5 per cent. manganese the Widmanstättian structure is clearly seen. Much work has been done in this connection and it seems reasonably certain that 1.6 per cent. manganese is not far from the boundary of the true solid solution of manganese in iron at room temperature. Chemical methods are to be employed in order not only to determine the solubility of manganese in iron at room temperature, but also to establish the identity of both constituents found in alloys.

Effect of Heat Treatment.

An extensive investigation of the alloys with 9.30 per cent. manganese, and that with 9.12 per cent. manganese, 0.30 per cent. carbon, was carried out, while the other alloys were used merely as a check for the recorded observations. Quenching normalising or annealing of the alloy containing 9.30 per cent. manganese does not alter its Widmanstättian structure, except perhaps for less perfectly defined patterns. When quenching temperature passes 955 deg. C. grain refinement takes place. The hardness curve, however, fails to register the increase in hardness due to grain refinement. The marked softening occurring on quenching from 2,100 deg. Fah. (1,150 deg. C.) cannot be explained by the metallographic study, since no marked change is observed in the structure of the alloy.

Holding the samples at different temperatures for different lengths of time prior to quenching (or any other treatment) has no influence whatever on the final structure of the sample. Some of the samples were held at high temperature for eight to ten hours, yet their structure was identically the same as of those that were heated only for half-an-hour or so. Apparently the dissociation of iron-manganese alloy into two constituents along the crystallographic planes (resulting in Widmanstättian patterns) is so rapid that it could not be checked by very rapid cooling such as in iced brine. No polyhedral structure of the solid solution type was obtained in this alloy under any conditions of quenching. It is also to be noted that apparently the dissociation of iron-manganese solid solution is accompanied by an allotropic change, because all of the alloys subjected to previously-described treatments are strongly magnetic. This makes it certain that either both, or at least one constituent, is a solution of manganese in non-gamma iron.

The heat treatment of the alloy with 18.87 per cent. manganese shows a similar permanence of the Widmanstättian structure under all conditions of treatment. Such treatment included annealing between temperatures of 1,700 to 2,300 deg. Fah. (925 to 1,260 deg. C.), and quenching from the various temperatures, even as high as 2,450 deg Fah. (1,340 deg. C.). In the latter case the Widmanstättian character of the alloy is much less pronounced, as if the drastic treatment succeeded, at least partly, in preventing the formation of clearly-defined Widmanstättian patterns. The hardness of the alloy is also lower after this treatment, while after all other treatments it remained practically the same, in the neighbourhood of "92 B" Rockwell.

The heat treatment of the alloy with 9.12 per cent. manganese and 0.30 per cent. carbon was studied in detail. General conclusions are as follows:—(*a*) The structure of the alloys remains Widmanstättian with clearly defined martensite-like formations under all treatments. (*b*) The hardness changes very little except for the break on quenching from 980 deg. C. (*c*) The alloy remains practically non-magnetic under all treatments.

The Associated Equipment Company, manufacturers of commercial and passenger vehicles, are effecting with the Ruston Motors, Limited, a progressive policy for the production of an efficient, yet cheap, all-British tractor. An industrial model will shortly follow, after the release of the agricultural type.

Waster Castings: their Lesson and their Prevention.

By A. E. McRae Smith, M.A., B.Sc.

Considerable attention has recently been attracted to the subject of waster castings in the foundry, and the editorial note recently published in this Journal was certainly a timely one. The writer is delighted to see this question discussed, and hopes that the greatest possible publicity will be given to the fact that foundries do make waster castings, in spite of the attitude adopted by a small minority, who would like to lead engineers to believe that they never heard of such a thing as a waster casting being produced in foundries under their control. No doubt in many cases the adoption of this attitude is the result of the wish being father to the thought.

Yet it is largely from the accidental production of waster castings that the foundry trade has been able to advance. Mr. H. J. Young, in his recent article on "Waster Castings," wrote very truly when dealing with this same subject, comparing the foundryman to an athlete, that it all depended on how high he wanted to jump, and when the foundryman wanted to clear the highest pinnacle, then waster castings, or to continue the simile, failures to clear the highest jump, can be turned to very profitable account for future achievement.

But the foundryman, like the athlete, must realise his own faults, if he is to derive the maximum benefit from such failures.

No waster casting, no matter how small or how unimportant, should be placed on the scrap heap, without the probable reason for its failure, at least being discussed, if not definitely ascertained. In at least 90 per cent. of such cases, by a carefully considered scheme of examination, but carried out scientifically and practically, it should be quite possible to establish definitely the cause of the fault, and where this is due to a cause *not* outside the control of the foundryman, the metallurgist and the designer, then the same failure should not re-occur.

The author is particularly associated with the production of high duty grey iron castings 85 per cent of which are tested either pneumatically or hydraulically, and in this particular branch of the foundry industry, one specially realises the importance of conscientiously examining all waster castings with a view to establishing definitely the cause of failure.

Division of Wasters.

Wasters may be divided up into many different categories, and very varied indeed are the lessons which may be learned from their study in one branch of the foundry industry alone, viz., the grey cast iron trade.

Before, however, one can deal in any way with the classification of wasters and their causes and prevention, etc., it is necessary to consider carefully, not only the various grades of grey iron casings, according to the service required of them, but also the quality aimed at, in each particular grade. Each class of casting has its own particular types of defects.

Some foundries in the grey iron trade produce only coarse, heavy and medium weight, castings, which are not machined. Such castings are usually quite suitable for the job for which they are designed, because the factor of safety is very high. They are mostly used by civil engineers, contractors and builders. Foundries producing such castings use mostly the cheapest class of scrap, and if they add any pig-iron to the mixture, it is of the cheapest, highly phosphoric, quality, and the resultant job is a very weak and brittle iron giving probably 9 to 10 tons per square inch tensile strength, from either a test piece 1 in. square section cast on any casting, or a test piece of similar dimensions cut from the particular castings. Such castings are usually moulded by crude methods, and no matter what the shape of the casting, they are cast in a horizontal position. The method of running and rising is a secondary consideration, because, provided the casting is reasonably near the shape of the pattern, and the top skin has not to be broken, it does not matter how poor the casting really is. Such castings are, of course, very low in price, but, unfortunately, some designers and engineers have a happy knack of calling for castings of similar geometrical proportions, which have to be machined all over, and they expect to purchase them at the same price per cwt. as the rough, coarse casting. A striking example came before the author's notice the other day when he was asked to quote for a plate casting 6 ft. long by 4 ft. wide, by 1½ in. thick, and to be machined all over, and give a perfect surface. The price quoted was criticised as being almost 100 per cent. too high, but after some investigation it was found that the comparative figure was for floor plates of similar dimensions, for making alley ways at a local cement works. Probably the engineer in question would have had a self-inflicted object lesson had he attempted to machine the top side of one of his stock floor plates.

Builders' Castings.

At the same time, even in this lowly grade of heavy builders' castings, much rubbish is produced at the present time, and one fears, yet hopes, that all the cast-iron cements so freely advertised in the technical Press, is used for this class of work. If, in the higher spheres of cast iron, one made perfect castings for disposal to the engineering trades, in all their ramifications, then there would assuredly be no market for cast-iron cements.

However, it is really rather a distressing point that many engineers seem to consider that complex alloy, which we know as cast iron, from its reputation as derived entirely from this lowly sphere.

The chief faults likely to be apparent in this particular division of the industry mostly consist of moulding faults. The degree of finish of such castings will usually depend on the price paid, and the wasters, which should not exceed 3 per cent., when one ignores the strength and quality of the iron, will be chiefly due to avoidable and unavoidable moulding troubles. When the moulding in this grade of work is carried out entirely by machines operated by unskilled labour, then one is bound to get a certain percentage of waste, but where the sand preparation, methods of running, cupola practice coupled with clear, hot metal quickly distributed, is available then the total scrap should never exceed 3 per cent. of the total output.

Domestic Castings.

A second, rather lowly sphere of activity in this class of foundry work is the production of light castings for the domestic trade, where no machining other than the drilling of holes is ever carried out. This trade naturally requires much more skill in moulding craft than the one already described, because many of the articles produced are only ⅛- to $\frac{1}{16}$-in. general thickness, and, therefore, in this trade moulding technique is of the utmost importance. Even the widely advertised iron cements are of little use for stopping defects in the domestic stove, copper, bath, basin, kettle, or saucepan castings, not to mention the ubiquitous gutter and rain pipe. In this class of production much depends on the skill of the moulder, but with modern methods of production, provided the foundry superintendent and the metallurgist are sufficiently skilled in the production of facing-sand mixtures, core-sand mixtures and the like, routine methods of mass production, with the aid of mechanical devices like the sandslinger, jarramming and other moulding machines, will give and are giving almost perfect results. Here, of course, metal plays an important part in the quality of the final article. What is aimed at is a fluid metal which will give strength combined with toughness in extremely thin sections. Provided the moulding methods and the metallurgy have been correct in this type of work, the wasters, including reasonable breakages in transport, should not exceed 7 per cent. In some cases in this trade it will be found that breakages in transport are excessive. Where this can be proved definitely not to be due to the carelessness of the carriers, then the foundry management in question should look to the composition of their metal, and if they do not employ a metallurgist they should immediately enlist the services of a consultant familiar with the metallurgy of the grades of cast iron necessary for their work.

As an adjunct to this class of casting, we have such types of grey-iron castings as instrument cases and similar castings for the electrical trade, thin-section ornamental castings in general, fancy grate fronts, name plates, cast-iron domestic fittings and the like, where the chief aim is to produce an article where the finish, direct from the mould, will be such as to be pleasing to the eye and yet admit of the finished article being cheaply produced. In such castings, finish is the chief point with the buyer, and one foundry's castings would be wasters as compared with the finish exhibited by another firm's castings, produced to the same design, but not necessarily from the same pattern.

Light Castings.

This brings us to the point that for light castings in general, especially those which are chiefly used for decorative purposes, patternmaking plays a large part in the degree of perfection of the finished castings. In such circumstances the foundry superintendent ought to have the power either to scrap, or to have modified, any pattern which, from rough and inaccurate workmanship, is not likely to give a sufficiently accurate or smooth mould to produce a 100 per cent. casting, not only in accuracy of shape, but also in neatness of appearance and smoothness of skin finish. Again, in this class of work the chief causes of scrap will be moulding defects, due either to bad moulding, bad patterns or unsuitable facing sand. Once the correct sand has been adopted, then prevention of wasters is merely a matter of supervision of sand preparation, patternmaking and moulding. Any laxity on the part of the producers will result in scrap castings.

The second group of causes which will bring about wasters in this branch of the trade is unsuitable metal, low-temperature metal, and incorrect methods of running and rising. Good, hot, clean metal, of the correct composition, poured into moulds at the correct predetermined rate, with correct distribution in the mould, will always give perfect castings. Once these factors have been mastered for any particular type of casting, then wasters should disappear. Not only in this branch of the grey-iron industry, but in all the others, metal which is too cold at the moment when it enters the mould causes more scrap than any other single cause. Now, this is a preventable thing, as there is no excuse whatever for any foundry being supplied with cold metal if the foundry superintendent or the metallurgist knows his job.

General Machinery Castings.

The next grade of castings to be considered is that large class known as general-machinery castings. This will include all castings, both light and heavy, which are used in the production of machinery of all descriptions, but it is convenient to exclude all parts which are required to retain liquids and gases under pressure, and castings which have to withstand wear and the like. These will be treated under a separate group. Some of the castings in this group, such as castings for sewing machines, light textile machinery, agricultural machinery, domestic machinery, and a great many others will be very similar in their requirements to those of the group just dealt with; *i.e.*, to say, apart from the fact that many of these castings have to be machined all over, clean, accurate, soft castings of just sufficient strength for the individual purpose, will usually fill the bill. In the heavier grades, maximum strength, coupled with material of such a texture as will permit of taking a good finish, yet be very easily machinable, is what is wanted. The causes of faults in this case will be exactly the same as in the previous two groups, with the addition that one must be prepared to produce a casting which is capable of being machined all over, without any sign of dirt, blowholes and other defects. Apart from the

usual accidents, such as run outs, cross joints, blown castings due to faulty vents, broken cores, lifted cores, scabbed cores and moulds, and the like, which are nearly always traceable to faulty tackle, careless moulding, coremaking and assembling, incorrect treatment and preparation of sand, lack of supervision, etc., a large percentage of scrap often arises from bad metallurgical and foundry technique. How often do we see machinery castings with dirt and blowholes on the top surfaces? Blowholes are mostly due to gases from the mould and core materials being entrapped in the still liquid metal. When the composition of the metal, the cupola practice and the method of running the casting is correct, then the percentage of wasters from blowholes will rapidly diminish, provided the moulding practice is also above reproach. Cold, badly melted metal is the cause of far too many waster castings or castings which should be wasters, the number depending on the standard of inspection and the quality of the final product aimed at. The precentage of wasters in grey-iron castings for general machinery should never exceed 5 per cent. of the total foundry output.

Pressure Castings.

Pressure castings, *i.e.*, castings which have to be subjected to pneumatic or hydraulic pressure tests probably cause the foundryman and the metallurgist more trouble than any other class of grey-iron casting. This group includes, amongst a multiplicity of other articles, such well-known castings as steam cylinders, liners and covers, air and other gas-compressor parts, internal-combustion engine parts, including Diesel engine parts and hydraulic engine parts. In this branch of the trade maximum strength together with good wear and often heat-resisting properties, are of the greatest importance, always coupled with perfection of surfaces after machinery, and the complete absence of porosity and openness of texture, in all sections of every casting. Very often castings in this sphere have, of necessity, to be of irregular section, which makes the foundrymen's task more difficult.

Here, the first essential to prevent wasters being made, is for the metallurgist to provide metal of the correct composition. This is especially important in the casting of heavy section hydraulic engine castings, where lumps of metal perhaps 12 in. or 15 in. in thickness will ultimately have drilled in them small passages required to stand up to a test of, say, 4,000 lbs. per sq. in. hydraulic pressure. The use of steel scrap, either direct in the mixture or by adding so-called refined or synthetic iron, together with closely-controlled silicon, phosphorus, manganese, etc., will usually give the desired result. It must be remembered that when dealing with this class of iron small variations in silicon, especially in the lower ranges, will exert a fundamental influence on the percentage of wasters, always assuming that metal temperature and rate of cooling is as constant as can be. If such castings are to be perfect, then cupola practice must be correct, and the metal must enter the mould at never less than 1,350 deg. C. Apart from faulty metal, shrinkage defects and "draws" usually occur from faulty methods of running and wrong design of self-feeders, where these must be used.

Division of Activities.

When a new casting of this type has to be made, the foundry superintendent (provided he has sufficient knowledge) or the metallurgist in consultation with the foundry foremen, must decide how the casting is to be made, and issue the necessary instructions to the pattern shop, moulders and coremakers. The metallurgist will decide on the metal to be used. If similar castings have previously been made, no difficulty should arise, but if an error of judgment should be committed with a resultant waster casting, then the critical examination and dissection of the waster should reveal the cause and prevent the recurrence, if it is humanly possible, of this same defect.

For example, take the case of a steam-cylinder casting or air-compressor casting, off a new design, which has failed on test. The usual moulding and coremaking faults are obviously ruled out, as it is assumed the casting has machined up perfectly, but leaks at one spot. The casting will be broken up and all sections carefully examined. A shrinkage defect will be found at the junction of some thick section. If the metal, on analysis, is found to be such as has always given good results on similar castings, then methods have to be decided on how to modify the rate and distribution of cooling (1) by the use of denseners on the heavy part, causing the trouble; (2) by means of a modification in the size and shape of the feeding head, where such is employed; (3) by a redistribution of the runners; or (4) by a combination of any or all of these essential features of the technique. Sometimes it may be considered necessary to apply to the designer for a little assistance by modifying, as far as possible, the inequality of the section at the point of trouble. In any case, whatever is decided on, the second casting should not fail from the *same* cause as the first. It may certainly also be a failure, but if the foundry staff are worth their salt, then the cause of the failure will be a different one. In extreme cases it may be that as many as half a dozen wasters are made from some really difficult job, but even then no two should fail from the same cause. Once the job has been made correctly, the result should be capable of repetition without failure, apart from such failures as can be definitely attributed to breakdown of foundry plant or tackle and such accidents as are beyond the control of the supervising staff, or are due directly to the carelessness of cupola staff, coremakers and moulders. The remedy for failures which can be directly traced to carelessness or lack of supervision is obvious and easily applied.

Imperfect Erudition.

In a great many cases in grey-iron foundries to-day a waster casting is replaced by other wasters from the same pattern, because the foundry foreman leads himself blindly to believe that he knows the cause of the fault, and, rather that have his lack of knowledge exposed, he is unwilling to subject the wasters to a really common-sense technical examination. After all, modern high-duty castings are imposing a great deal of extra responsibility on the foundry trade, and the skilled artisan need not be frightened to enlist all the aid he can.

The examination of all wasters, no matter how unimportant they are, must be carried out not only carefully but also sensibly and impartially. The author has only mentioned a few types of castings, but the same remarks apply to all grades of grey-iron castings. It is impossible to give a reliable figure for the waster percentage likely to arise in the field of pressure castings, but it may be anything from 3 to 50 per cent. when applied to any individual job, but the average on this class of work should certainly never exceed 10 per cent. On standard repetition work, of course, it should be lower, but on new jobs it may reach a much higher figure, to be reduced when the correct standard method has been arrived at. It is quite likely that certain foundrymen will say they can produce motor cylinders, steam cylinders, air- and gas-compressor parts and the like either without scrap or with perhaps only 3 to 5 per cent., but when a foundry is continually dealing with new designs and improvements, there is not much wrong with the organisation and its staff if the percentage of wasters is kept under 10 per cent.; and under 5 per cent. for repetition of old work, these figures covering scrap from all causes detected, not only in the foundry, but in all the other stages of manufacture.

Logical Examinations.

A scheme for the examination of waster castings of all grades, which the author has found to work well, is as follows:—All scrap castings discovered in the foundry are examined daily at a definite time. Small scrap castings detected by the inspectors in the machine shops, etc., and in the test department, in the case of castings subjected to test, are collected daily at one or more points, and also examined at a definite hour. Large castings are examined provisionally *in situ*, on the metallurgist being notified by the inspection department. In every case the foundry foreman responsible for the production of the particular casting or castings is present. The scheme of fault-finding and the suggestion of remedies is carried out in the following order:—

(1) Faults obviously due to core-making, moulding, and assembling such as cross joints, swollen or mis-shapen castings, lifted or broken cores, crushed moulds, scabbed moulds or cores, "run outs" or the like. Each individual casting is discussed, and the reason and proposed remedy noted in the "Casting Faults Register," which can be referred to at any time. This applies to all types of faults. Where necessary any faulty pattern and tackle is sent for repair or alteration, and disciplinary measures are taken where required.

(2) Faults obviously due to incorrect metal, such as hardness, undue softness, openness of texture, etc., are examined. Sometimes this will be found to be due to lack of supervision, the wrong grade of metal having been poured in the moulds; sometimes it will be found to be due to some error in charging or tapping from the cupola, in which case the necessary steps will be taken to prevent its recurrence.

(3) The castings may be "mis-run." This will be due to one of two causes, either cold metal or incorrect size and distribution of runners. If from the latter cause, the necessary alterations are made and a record kept. If from cold metal, the reason must be either bad cupola working, in which case there will be much scrap, or excessive delay in casting the job after the metal has been tapped or transferred to "shanks."

(4) Scrap due to the discovery of sand, slag and blowholes on machined surfaces. As already stated, the chief cause of blowholes is cold metal. Where it is known that the temperature of the metal is correct, then the porosity of the sand, dampness of the sand in green sand work, venting of the cores and mould, defective or ineffective running and the like must be looked to. A frequent, but easily preventable, cause of much of this trouble is bed skimming, slovenly made pouring basins and down gits. Faulty blacking of cores and moulds may also give trouble, as will badly-dried moulds. With experience it becomes easy to distinguish one type of trouble from another, and once the cause has been definitely established, it is fairly easy to provide the remedy.

(5) Scrap due to rod feeding on heavy lumps such as couplings, flywheels, bearing shells, heavy brackets, balance weights and similar castings. Where much unskilled labour is employed, it is sometimes difficult to deal with large quantities of such castings on any one day, if the best results are to be obtained. The castings mentioned are only representatives of a very large class. Where possible, rod feeding should be eliminated, by adopting self-feeding methods, such as the use of feeders and pencil runners, etc. Castings to withstand pressure should on no account be fed with rods. To do so is to court disaster. Where heavy flanges on pipes or flat, lumpy covers, glands, etc., cannot be got sound, it will sometimes be found advisable to feed *off* the casting but never *into* the casting.

(6) Faults due to use of chaplets not becoming sufficiently amalgamated with the casting. Chaplets should never be used in any pressure casting where other methods of core anchorage can be economically applied. Many foundrymen use chaplets unnecessarily, merely because it is the "least trouble" way. Where essential, the design of the chaplets should be carefully studied.

(7) Wasters due to porosity are usually revealed on pressure test. The cause of such is usually the least obvious, but in nearly every case they will be found to be due to two main causes—(*a*) unsuitable metal both as regards composition and temperature; (*b*) lack of provision of correct cooling conditions so as to ensure that liquid shrinkage is filled up as solidification takes place.

Cause (*a*) is readily discovered by analysis of the metal of the waster. The more perfect the metal, the less need is there for precautions to prevent failures from cause (*b*).

Failures from cause (*b*) can be overcome, as already described, by adopting the use of self-feeding heads, denseners and suitable methods and rates of running; asd, provided the moulding and coremaking is correct, such porosity defects, once they are eliminated on any one job, should never recur a second time.

Further Steps Towards Standardisation.*

By Oscar Quérut.

When the author and his colleagues of the Pattern Standardisation Committee started examining the elements of that question, they were antecedently attracted by the idea of a standardisation of the method of moulding which would form the basis for standardising the characteristics of a particular pattern. Attractive as this idea was, they were nevertheless compelled to abandon it at the outset of their deliberations, having decided that it could be realised only under conditions in which the casting in question had been completely standardised, but this was a state of things still too remote for profitable consideration. In view of contingencies which it was impossible for them to avoid, the committee had agreed to recommend the application of general methods subject to the possibilities of individual cases.

While, however, it had been impossible for them to prescribe that a particular pattern should be designed in the same manner, from the point of view of moulding, in any and every foundry, they had come to a unanimous decision of the utmost importance in regard to it. This was that in future it should not be made without all the features of its construction having been first of all entered in a manufacturing schedule, the general rules taken from the specifications of its standardisation being applied. They had, therefore, in fact, instituted the principle of method in pattern making. It mattered little for the moment that this method was given interpretations and applications that were not always synonymous with a maximum output. The essential thing was that there should at last be method instead of the disorder amid which the pattern-making industry had hitherto evolved.

If, however, the beneficial results of this methodical movement were to exercise a favourable and immediate reaction in the general economy of moulding when it was applied, this depended on the moulder doing something on his part to complete the work of the pattern-maker—something which being superimposed upon that work, would be adapted to it. The something in question was the institution of a moulding programme. If patternmakers, justly concerned about the reputation of their craft, had condemned everything in the nature of arbitrary ideas and construction in regard to patterns by subjecting them to strict regulations, why should the foundry world any longer remain indifferent to the adoption of similar regulations in regard to moulding? He could see no reason why it should.

A brief comparison of the relative importance of a moulding programme and a pattern-making programme, in connection with a particular casting, was enough to show at once that the former lay on a much higher plane than the latter. The impression received from the comparison might be expressed by saying that the importance of the pattern was rather of a superficial nature, while that of the moulding went much deeper. He proposed, therefore, to analyse briefly a general moulding programme, and from his analysis they would draw the natural conclusion that if good constructional programmes were necessary for making good patterns, good moulding programmes were also necessary to make good moulds and good castings.

Moulding Programmes.

When the question of patterns and moulds was thoroughly studied in connection with particular castings there could be no doubt as to their intimate relationship. It was, in fact, upon the moulding programme that the pattern-making programme would always be based, so that if the patternmakers had decreed that a manufacturing programme for patterns was to be followed, they had logically placed the founders under an absolute obligation to adopt the principle of a moulding programme. By so doing, had they caused the founder to face a problem so novel that its solution demanded troublesome labour? By no means, at least so far as a certain number of founders were concerned. Just as up-to-date patternmakers had not waited for the standardisation order, but had long ago put it into practice of their own accord, in the same way competent founders would have no difficulty in adapting their present methods to those which he proposed to include in the moulding programme. There had always been pioneers and laggards, particularly in the sphere of foundry work, and when they were discussing standardisation it was quite possible that this might not mean any step in advance for those who were already ahead, but it was at least certain that they would be urging forward the great mass of those who were backward, so that the distance between the two would be reduced, to the great advantage of all.

Nature of Moulding Programme.

Such a programme should comprise: (1) A study of the best method of moulding the casting, not necessarily from the point of view of the available equipment, but particularly from that of the elements governing its successful casting. The manufacturing programme for the pattern was dependent upon this method of moulding; (2) the determination of the shape and dimensions of the risers, any risers used and the runners, as well as their respective positions in the pattern; (3) the selection of the moulding boxes if the available plant permitted, or their suitable construction. It should be noted that this selection of the moulding equipment could not be effected until the second question had been thoroughly solved, as the shape and dimensions of the boxes must be dependent on the pattern together with all its pouring accessories. Even if the moulder might not go so far as to disregard every consideration of safety, the vital questions of the distribution of the metal in the mould and its ejection in the risers were too often sacrificed in order to enable the moulding boxes available to be used.; (4) an indication of the nature of the sand to be used, supplemented by particulars of all the delicate points in the moulding and remoulding.

This was certainly a complex programme, but it was within the capacity of the founder. Would it require the establishment of a new function in foundries? Possibly it would. In a large foundry it would be essential. In one of medium extent, the manager or the proprietor-manager would be responsible. In any case it was necessary that in every foundry there should be a man whose duty it would be to study the castings, and who, being permanently in touch with the pattern shop, the moulding shop, and, if necessary, the machine shop, would be able to make full use of the plant and labour for the production of the best moulds and the best castings at the lowest cost.

Corollaries of a Moulding Programme.

The adoption of the principle of a moulding programme opened the way to two classes of studies: that of small and medium castings and that of large castings. Taking the class of small and medium castings, they had to consider that the first object of the foreman moulder was to produce a maximum of castings per moulding unit for a minimum of material used in their production. The problem to be solved therefore was this: Taking into consideration the manual and mechanical means of handling available in a foundry, what moulding box plant was most adequate for the maximum production of particular castings? This simple question necessitated a survey of the equipment in question, and as it would have to be asked almost daily—for it was always important and urgent—it could be answered only if the foundry possessed a complete schedule showing full particulars of all the boxes in use. The first result of adopting method in moulding would therefore be expressed at the outset in something that was essential: a list of all the moulding boxes, with sketches showing their shape and dimensions, these sketches being classified and numbered.

Immediately this method was applied, most foremen moulders would find that the equipment at their disposal was heterogeneous, having frequently been made long before under the pressure of circumstances, the disparity being also due to the different degrees of ability successively displayed in its construction, and the need for introducing order into such material would be irresistibly impressed on their minds. The way would thus be opened for its standardisation. Having been gradually improved it would ultimately be transformed into an equipment in which the dimensions would be systematically graduated, while these improvements in proportion and form would be supplemented by the introduction of standardised registering devices. This new equipment, the result of method, would now be numbered in clear figures cast on the sides of the boxes. Having been drawn and catalogued, it would constitute in the hands of a foreman moulder a precious collection which would no longer leave any room for uncertainty or error. It meant an immense step in advance, order based entirely on method and extreme certainty in the general economy of casting.

In the production of large castings a foreman moulder would have to face in a similar way the important question of large moulding boxes and permanent platforms, or, in other words, working floors. All founders of large castings knew the great cost of having to make large moulding boxes unexpectedly when it was impossible to use existing boxes owing to a difference in dimensions of a few centimetres. Why should they not consider the introduction of new heavy expansible equipment, even if it had to be finished roughly to enable it to be used immediately. One could well conceive a large complete framework capable, for example, of being increased one metre in length and breadth by sliding four large squares forming its corners over four side beams carrying the trunnions, instead of some sort of frame which was extended by minute intervals only. The inner walls of this framework would be fitted with slots in which the special cross pieces which had to be cast for a particular piece of work would be clamped or bolted. If attention was paid to the question of ribs and strengthening pieces at the exposed parts, there would be no risk of the framework bending.

Pursuing these considerations affecting moulding, one's attention was arrested by the fact that in most foundries producing large castings, holes, sometimes enormous, were frequently being excavated in the floor, at the bottom of which platforms for the erection of the moulds had to be placed, these platforms being such as frequently to cause well-founded apprehension when casting. Certain castings had obviously and necessarily to be moulded in that manner, but how many there were that could be moulded perfectly well on the floor level of the foundry if the requisite plant were available? He was greatly in favour of a permanent working floor, more or less in the shape of a basic framework, expansible if required, like the moulding boxes intended to be adapted to it.

This framework was provided with a false bottom of inserted plates pierced with holes for carrying off the air. These plates carried a permeable brickwork structure coated with a thin layer of moulding loam, the surface of which was scraped level. The gases from the mould passed into the false bottom of the framework and were carried out by evacuation pipes. What was the advantage of this working floor? It accelerated the initial moulding operations, reduced the cost of labour considerably, and did away with the jamming of castings at the bottom of the moulds owing to their solidity. There were no longer serious ebullitions of metal to the surface and, in particular, no invisible escape of metal by the bottom, if care had been taken to pierce openings in the flooring, by which any escape would be at once detected.

This brief sketch of the improvements applicable to the moulding plant of large castings did not complete the considerations arising from the application of method in the moulding programme, and

* Paper presented to the Foundry Congress of 1928. The author is a technician in patternmaking at La Louvière, Belgium. (Exchange paper of the Foundry Technical Association of Belgium.)

in closing this brief study the author believes he could not illustrate the value of such method better than by relating the following incident. A few years ago he suggested to the manager of a foundry producing large castings the idea of entering, in a special register for the purpose, the general plan of all the large castings that might be required. This was, in fact, the application of the principle that a casting should never be produced without being accompanied by its preliminary moulding programme. The initial steps were very troublesome, as the pages of the register showed, but now the plan of a large casting could be adjusted in a few hours. What did this plan comprise?

(1) A diagrammatic longitudinal and transverse section of the casting in its mould in the pit or in the moulding box: (2) the method of distribution of the metal in the mould, and the arrangement of the risers and vents: (3) an indication of the delicate points in the moulding or remoulding, with a short note drawing attention to the precautions to be taken: (4) a note relating to the weight of the metal to be provided in the ladles, the particular precautions, if any, to be observed in casting and the requirements in regard to the casting temperature. As could be seen, nothing was left to chance.

In the margin of the drawings there was subsequently entered a clear specification in which were entered, along with the total time taken by each class of workmen in completing the moulds, the remarks which the foundry manager had thought it necessary to make with regard to the whole of the moulding and casting operations. The weight of the casting after cleaning and the cost price per 100 kg. of the casting were also added. At present this register constituted for the foundry possessing it a veritable encyclopædia of its operations. The management might change without causing the slightest inconvenience. It was simply a matter of consulting and comparing the data and going ahead. There could no longer be any serious error of judgment, while the certainty of success was enormously increased. Such was the result of applying the method which he would like to see generally adopted.

Newark's Foundry Students.

Everything possible is being done to stimulate interest among the foundry and engineering workers in Newark, and there was a good attendance of members at a meeting of the local society to hear a Paper on "Centrifugal Pumps," given by Mr. B. M. Woodhouse. Mr. J. Marsland presided.

Details of a scheme for all young engineers in the district were considered, and it was agreed to offer a substantial prize for the best original Paper read before the society by students. A scheme of this kind has already been promoted by the joint engineering societies of the East Midlands area, and Messrs. J. T. Graham, who is the works manager of Messrs. Worthington-Simpson, Limited, Lowfield Foundry, and C. G. H. Richardson have consented to represent the Newark Society on the panel of adjudicators.

There is a complete change of fare for the next meeting, which is to be held at the Science and Art School, when two films will be exhibited, one being by Messrs. Morris Cowley (1926), Limited, showing the manufacture of a motor car from start to finish.

Greensand Workers' Wages.

The Greensand Pipe Founders' Association, consisting mainly of Scottish Foundry Employers, and the Light Metal Trades' Union, have agreed to a reduction of 5 per cent. from the existing floating percentage rates. The respective constituents are being recommended to accept the arrangement which is similar to that reached for the men employed in the production of rainwater goods. The suggestion is that the reduction should operate from January 1.

Heat Treatment of High-Speed Steel.

This important operation was the subject of two Papers put forward to the American Society for Steel Treating at their meeting, held in Philadelphia in October.

The first was by Mr. H. C. Knerr, and was entitled "A New Method for Heat Treating High-Speed Steel," and the chief features of the method described included electrical heating, close temperature control, which could be made automatic, the use of a salt bath which did not give off fumes or attack the tools, prolonged container life, absence of furnace deterioration, comfortable working conditions, low heating cost per pound of steel, and the ability to employ full hardening temperatures (in the neighbourhood of 1,315 deg. C.) without injury to finished surfaces or cutting edge of high-speed steel tools.

A new liquid bath had been developed which showed excellent characteristics at temperatures as high as 1,340 deg. C. The mixture was rather viscous just above its melting point, but at temperatures above 1,230 deg. C. it was sufficiently fluid to permit strong convection currents to be set up, which assured temperature uniformity within the container. Even at the highest temperatures (1,340 deg. C.), a film of molten salt adhered to the piece of steel when removed, protecting its surface from the atmosphere during transfer to the quenching medium. When uncontaminated from outside sources, the molten salt was neutral to steel, neither visibly attacking its surface nor causing serious carburisation or decarburisation. There were no fumes, and its cost was moderate.

The speaker also said that finished tools of various types had been heat treated at 1,285 to 1,315 deg. C. without any mark upon the surface other than a slight discoloration. Sharp cutting edges were practically unaffected and retained file hardness. No pitting, scale, or other surface defects occurred when the treatment was properly carried out. There was no warping, provided, of course, internal strains had been removed from the tools before treatment. These tools were quenched in oil and tempered either in a salt bath or an electric muffle furnace at 585 for from 1 to 4 hours. Rockwell hardness of 62 to 65 was obtained on the surface after tempering.

Drills, thread cutters, files, file-cutting chisels and lathe tools treated by this method had been tested in service. Results compared favourably with tools treated in the open furnace and ground, and were superior to tools treated in salt baths at the customary lower temperatures.

Lead Bath for Heating.

The second Paper was given by Mr. W. C. Searle, on "Heating High-Speed Steel in Molten Lead," and described the apparatus and method of heating high-speed steel at 1,260 to 1,315 deg. C. in molten lead. The process was suitable for tools, such as flat cutters, circular-form cutters, reamers, etc., which were all hardened successfully by this method. Preheating was done usually in an electric oven furnace equipped with an automatic control. The control was set for 870 deg. C. A gas furnace was used for heating the lead, which was contained in a graphite crucible.

Pieces were taken from the preheating furnace, one at a time in a pair of tongs, and held in the molten lead for a definite number of seconds, depending on the size of the piece. The ends of the tongs were just above the lead surface. The piece was removed at the end of the immersion period and dropped into a basket in the quenching oil. At the end of the heat the pieces were removed from the quench, washed in hot washing compound and placed in the electric furnace for tempering at 565 to 590 deg. C.—("The Iron Age.").

The second "William Menelaus memorial lecture" was given before the South Wales Institute of Engineers on Thursday by Professor H. C. H. Carpenter, who took as his subject "The Mechanical Properties of Single Metal Crystals and Crystal Aggregates."

United States Copper Industry.

Steady Increase in Domestic Consumption and in Exports.

The copper industry in the United States has shown steady improvement throughout the current year, and now occupies a stronger position than it has enjoyed over a considerable period—stronger in regard to the volume of business, prices and earnings. The price of copper, at the present time, is at the highest level it has reached in five years.

The "Guaranty Survey," the monthly publication of the Guaranty Trust Company, of New York, states that this is not surprising in view of the recent unusually active world demand, and the disproportionately small increase in production. Although the price of electrolytic copper at New York stood at 15½ cents per pound on October 23, and the average for September was 14.83 cents, the highest monthly average reported since June, 1923, copper is still one of the few commodities priced below its pre-war level. The highest monthly average price in 1923 was 16.96 cents, while the average for that year was 14.61 cents.

For many years the chief problem of the copper industry has been one of over-production and depressed prices. The United States has the largest copper smelting and refining industry in the world, and produces about 52 per cent. of the total supply of refined copper from ore from its own mines. Practically all of this entirely domestic copper is consumed in the United States; while the large exportable surplus is acquired through the refining of imported, concentrated and unrefined ore, most of which comes from mines in Chile, Mexico, Canada, Peru, and the Belgian Congo. In general, the United States produces about half of the world's supply of copper from its own mines, and, through the refining of imported foreign ore (practically all American-owned) controls the greater portion of the world's supply. On the other hand, consumption in Europe is far in excess of the combined production in Europe and Africa; with the result that England, France, and Germany are especially dependent on the copper resources of the United States.

Shipments Exceeding Production.

Up to the beginning of the current year, production was within reasonable proportion to shipments, as reported by the American Bureau of Metal Statistics, but early in this year shipments rose to a level far above production, a situation that has not been substantially altered up to the present time. The increased domestic demand is chiefly attributable to the stimulated activity in the four leading copper-consuming industries in the United States. In the first half of the current year, consumption of copper in electrical manufactures increased 5 per cent., in automobile production 12 per cent., and in building lines 7 per cent., as compared with the respective totals for the first half of 1927. The total increase in consumption by these three industries for the first six months of the current year was approximately 8 per cent. above the consumption in the corresponding period last year; while there was a similar increase of 14 per cent. in the amount of copper used in the manufacture of products for export. To offset these increases in consumption, there was an increase in North and South American production of only 2 per cent.

As a result of these recent high records of shipments, stocks of refined copper in North and South America, on September 1, amounted to only 54,793 tons, or 58 per cent. of the total supply on hand at the corresponding time last year. At the beginning of the current year stocks of refined copper amounted to 96,800 tons, and the diminution has continued, almost without interruption, since then. Production has gradually been creeping up to shipments in the last few months, and the present productive capacity is adequate to take care of any probable increase in demand for some time. It is considered that the prospect for an increase in exports is good, and that the recent decline in German demand is being neutralised by increasing exports to other European countries.

British Association Meeting in 1929.—The British Association is to meet in South Africa next year (Cape Town, July 22 to 28; Johannesburg and Pretoria, July 31 to August 7, with subsequent tours). For copies of the preliminary programme and terms of membership apply to the Secretary, British Association, Burlington House, London, W.1. Following the precedent of 1914, when the Association met in Australia, the French Association for the Advancement of Sciences and the City of Havre have invited members of the British Association not attending the South African meeting in 1929 to attend that of the French Association in Havre, which will probably be held in the later part of July.

London Metallurgists Criticise German Research Work on Cast Iron.

At the November meeting of the London Section of the Institute of British Foundrymen, held at the Engineers' Club, Coventry Street, W.1, Mr. John Shaw initiated a discussion devoted to the consideration of points raised in the Paper by MESSRS. P. BARDENHEUER and K. L. ZEYEN, on "Graphite in Grey Cast Iron" (published in THE FOUNDRY TRADE JOURNAL, August 23, 1928, page 133), and criticised in our issues of November 22 and 29 by Mr. Shaw. Mr. W. B. Lake (Branch-President) was in the chair.

Underlying Principles for Research on Cast Iron.

MR. J. G. PEARCE (Director and Secretary, British Cast Iron Research Association) said that Mr. Shaw's remarks constituted an extension of the general criticism he had made in an earlier Paper, entitled, "Theory and Practice in the Grey Iron Foundry." Mr. Shaw had argued that we should experiment on actual cast irons, and not on synthetic metals produced from American washed irons, Swedish iron, and pure bases of that type. In order that his own remarks should not be misconstrued, Mr. Pearce reiterated what he had said in the discussion on Mr. Shaw's previous Paper, *i.e.*, that both methods of approach were necessary, and that we should dispense with neither. Bardenheuer and Zeyen would be the last men in the world to object to Mr. Shaw's criticisms; scientific Papers were written in order to produce criticism, and it was by criticism that progress was made. The fact that the German work was criticised should not blind us to the very great value of German metallurgical research of the last 15 years. German metallurgists had got ahead of us, and had carried out a very large amount of valuable, painstaking and accurate work.

It was not generally realised, he believed, how expensive it was to carry out the necessary translation and to circulate the results, but it was very necessary, and ten times as much of it could be carried out with profit. We were perhaps a little more slow in reporting results, and more cautious than the Germans in expressing them. Mr. Shaw had emphasised the differences between synthetic iron and ordinary cast iron melted in the ordinary way, but he (Mr. Pearce) believed that cast iron had not what might be called an "inherent cussedness," and that the differences were susceptible to explanation. He believed that cast iron was not peculiar, but that it obeyed ordinary metallurgical laws in the ordinary way. The only difficulty was the extraordinary complexity of the material. Much valuable information had been obtained by the study of the differences between synthetic and ordinary cast iron, and that was why he insisted that both methods of approach were necessary.

Does Graphite Exist in Molten Cast Iron?

One of the most important and interesting parts of the Paper was that dealing with the effect of superheating, and there was much experimental evidence to show that superheating in some respects did refine the graphite. That must not be expected invariably, and Mr. Shaw had referred to experiments which showed that it did not always happen. With regard to quenching experiments, he said that they had their limitations. They had often been carried out in order to determine whether the graphite in a cast iron resulted from the breakdown of the carbide which was formed in the melt, or whether the graphite was deposited as such from the molten metal. If a pig were melted at fairly low temperature, the free graphite which it contained in the first place did not all dissolve in the molten condition. The experimenter had quenched the sample and found some of the undissolved graphite in the quenched specimen, and wanted to argue that the graphite must be deposited from the melt, because it would not have had time to change over if it had been deposited first as iron carbide. If, however, the pig were melted at a high temperature in the first place, the graphite would be dissolved, and only iron carbide was found in the quenched specimen. In that case it could be argued that graphite was a decomposition product of iron carbide. He suggested, however, that neither of these tests signified anything at all. The graphite might come from the carbide, the solid solution (austenite) or the melt itself. He did not wish to argue which way it was formed, but it would be formed in different compositions at particular rates of cooling, and one could not expect a particular quenching experiment to show which process was involved, any more than one could expect 1-in. mesh wire netting to serve as a mosquito net.

Chill Cast Pig-Iron as an Ameliorative.

It seemed to him that the experiments on superheating suggested very strongly the desirability of the chill casting of pig-iron. Was there any real difficulty in using, in the cupola, pig-iron which had been cast in the chill? (He did not mean white iron, but ordinary foundry mixtures cast in the American fashion in the triangular chills, and in which the graphite was either non-existent or existed in very fine form.) He was aware that the adoption of that system would necessitate the complete abandonment of the system of grading by fracture, and would probably render essential the regular chemical control of pig-iron, but he was not sure that that would not be a very good thing.

The principal ground of Mr. Shaw's criticisms of the German work seemed to be that the changes in the properties of the irons were due, not to superheating, but to alteration of composition consequent upon the metal taking up something from the lining of the crucible, or the oxidation of the carbon. Under ordinary conditions it seemed practically impossible to separate one from the other. He thought there was something in superheating, quite apart from change of composition. If these changes in the composition of the irons were consequent upon superheating, why not record them as advantages of superheating? He had been interested in the remarks of Mr. Gresty on graphite, and said that the Research Association was giving illustrations of the extraordinary differences in graphite size, or apparent graphite size, due merely to the different ways in which the specimens had been prepared.

High Strength Ferrite-Graphite Irons.

Mr. Shaw had emphasised the very high strength of ferrite-graphite irons, in spite of their high silicon contents. A few months previously it was believed that this structure could be obtained only with particular compositions by chill casting, but it had since been found that it could be obtained in sand castings. One could get such a structure right across a specimen 1-in. thick, but it was not always that irons with the graphite in the finest form had the greatest strength. Schuz had carried out some work in this connection and had tried to obtain a patent, but had failed to obtain it. There was no doubt, however, that the structure was of very great interest. It was not mechanically weak; in fact, it might be quite as strong as, or stronger than, a pearlitic iron, but, so far as one could tell in a very general way, the metal would not stand up very well to abrasive wear, as it was too soft. Under some conditions of abrasive wear it might behave badly, and under other conditions it might behave particularly well; the difference could be ascertained only by practical test.

Chill Cast Iron Available.

MR. SHAW, replying, acknowledged the indebtedness of the industry to the British Cast Iron Research Association. Mr. Pearce was perhaps not aware that Armstrong's iron was largely chill-cast, and practically all the Swedish pig was chill-cast. Mr. Pearce's statement with regard to high-silicon iron was, he believed, quite wrong; those irons which gave high test figures were not ferritic. The highest figure—28 tons—was obtained with an ordinary iron which was sand cast. If Mr. Pearce could provide clear proof that the graphite did not all dissolve in the melt in the first place, it would be a definite step forward. This free graphite acting as nuclei would account for some of the difference in bars of the same analysis. A glance at the current issue of the B.C.I.R.A. Bulletin, where six out of eight Papers dealing with this subject, all take for granted free graphite does exist, with rapid cupola melting.

Graphite Not Found in Liquid Centrifugally Cast Iron.

MR. J. E. HURST (Sheffield) also acknowledged the extreme value of Papers presented by Mr. Shaw, and said that their great value was due in large measure to the deliberately provocative statements made in them. No doubt it had been noticed by most people that whenever Mr. Shaw was persuaded to present a Paper, a wide variety of questions were ventilated, both in the discussion and in the technical press. The great difficulty in dealing with Mr. Shaw's Papers was to determine what his (Mr. Shaw's) own beliefs were. With a good many of the statements made by Mr. Shaw in the present Paper he was largely in agreement, but he would like to deal with some of Mr. Shaw's rather provocative statements. The first related to the possibility of the existence of free graphite in molten cast iron. Mr. Pearce had viewed that matter from an angle rather different from that of Mr. Shaw. Apparently Mr. Shaw was not referring to whether graphite itself or carbide was the first to be deposited when molten iron solidified, but was discussing the possibility that free graphite might exist in the liquid cast iron melted in the cupola—and apparently the German workers supported his conclusions. Mr. Shaw had said that, due to the short time occupied, and the temperature applied, in the melting of cupola metal, free graphite was seldom absent from molten cupola iron. That was a very sweeping statement, and it was interesting to consider this from another point of view. He himself was fortunate in being able to centrifuge cast iron. It was the practice at his works to spin it in a manner similar to the manner in which milk was spun for the purpose of separating the cream, and in the spinning of cast iron it was found that those materials which were insoluble and had lower specific gravity were segregated and moved to the inside surface, as was the case with the cream in the milk. Sulphur, as manganese sulphide, moved definitely in that way and was segregated. He had never carried out experiments with the definite object of ascertaining whether graphite could be moved in infinitesimal quantities, but he had never found that there was any appreciable segregation of free graphite under those conditions. One would expect that, if free graphite did exist in molten cast iron, there would be a very appreciable movement, in view of its very low specific gravity—less than half, or probably about half, that of manganese sulphide. Since he had commenced centrifugal casting he had used an enormous number of different pig-irons, under a wide variety of conditions, but he had never found that there was any appreciable segregation of graphite resulting from the centrifugal process used in his works. The absence of segregation under these conditions was a strong argument against the possibility of free graphite existing in re-melted molten metal in the cupola.

Large Graphite and High Tensile Strength.

With regard to the size of the graphite in the structure, again it was difficult to determine what were Mr. Shaw's own beliefs. In one part of his Paper, actually quoting Bardenheuer, it was inferred that the size of the graphite was the all-important factor, whereas in another part of the Paper it was inferred that the matrix was very important too. Mr. Hurst exhibited slides showing the microstructure of centrifugal castings, with a view to illustrating the influence of graphite size. The first two slides showed the structure of a centrifugal casting of fairly thin radial section, made in a metal mould, the magnification being respectively 50 and 200 diameters. They illustrated the very fine graphite structure characteristic of centrifugal castings. The tensile

strength of the casting was about 16 tons per sq. inch. Further slides were exhibited of the structure of a centrifugal casting cast in a sand mould, the magnification in these cases being 200 diameters; the size of the graphite in these cases was large. A difference between the castings with the fine graphite and the castings with the coarse graphite was that in the one case the silicon content was between 2 and 2½ per cent., whereas in the other case the silicon content was between 1 and 1½ per cent. The tensile strength of the material with large graphite was 26 tons per sq. in., as compared with 16 tons per sq. in. in the case of the material with fine graphite. Thus, in a large number of castings a very much larger graphite size was accompanied consistently by a tensile strength which was higher by many tons than that of the castings containing fine graphite. One was forced to the conclusion, therefore, that the graphite size was not the all-important feature.

Influence of Quantity of Graphite and Grain Size.

It was only fair to say that there was less graphite in the material where the graphite was coarse than in that in which the graphite was fine, but it was only about 0.25 per cent. less on the average, and he did not consider that that in itself was sufficient to account for the difference in strength. In the material in which the graphite was coarser the silicon content was lower. Another slide showed the matrix, magnified to 1,000 diameters, showing the pearlite grains and large graphite flakes. He was indebted to Mr. Pearce for the slides. Mr. Pearce, in his report, had stated that the grains were extremely small, and the pearlite laminæ were extremely difficult to resolve. The grain size of the matrix in addition to the graphite size is one of the factors which will have to be given greater consideration in future investigations of the strength properties of cast iron.

Dealing with superheating, Mr. Hurst drew further examples from centrifugal casting experience in support of the evidence of the valuable effect of superheating. There can be no doubt that one of the factors contributing to the successful production of many of the intricate castings to-day is the realisation of the importance of both high superheat and high casting temperature.

In concluding his remarks he wished to reiterate that he was in agreement with many of Mr. Shaw's statements, and felt that the evidence he had offered served to confirm many of these statements. The whole industry is indebted to Mr. Shaw for the valuable discussions created by his Papers.

Insufficient Control Exercised.

DR. M. L. BECKER (Metallurgical Department, National Physical Laboratory) said he could not help agreeing largely with Mr. Shaw's remarks regarding the research work of Bardenheuer and Zeyen, and he had felt that there was something wrong with the method they had adopted in their first series of experiments. He would not go so far as Mr. Shaw, and say that he disagreed with the use of small quantities, but he did not think that Bardenheuer and Zeyen themselves would say that it was advisable to have such large variations in composition, which, as Mr. Shaw had pointed out, must have been due largely to the small quantities used. It was practically impossible to say that the results obtained owed their order entirely to the variable that the experimenters were attempting to control because other variables were out of control. However, as one who had to carry out this kind of research, he could fully understand why such a state of affairs had arisen. One started a research, and, having got about halfway through, one felt that one would like to start again, but, of course, time did not permit; there were other things, perhaps, of a more pressing nature, and one had simply to continue and to make the best of it.

Influence of Refractory Materials.

Dealing further with the question of the quantities of material used, he pointed out that in an ordinary laboratory the expenses would be very high if one worked with large quantities always. The method of control would often be more difficult. He recalled an instance in which the constituents of the pot, or containing vessel, had contaminated the metal itself. That experience was only too common, and quite a large proportion of the staff of the Metallurgical Department of the National Physical Laboratory were engaged entirely in making special kinds of refractories for each investigation, in an attempt to overcome this difficulty. He believed they had overcome it to a very large extent. It must always be borne in mind, however, that the larger the melts, the more difficult it would be to make a satisfactory refractory. One reason was that the mechanical properties of the refractory were often insufficient to withstand great weights of metal. At the same time, he agreed that in the particular work carried out by Bardenheuer and Zeyen larger quantities of metal should have been used, and that the difficulties they had experienced would have been overcome thereby. Finally, he emphasised the great value of Mr. Shaw's fair criticism of the work done in laboratories.

Discrepancies Due to Insufficient Knowledge.

DR. ARTHUR B. EVEREST (London) expressed his appreciation of the very valuable work Mr. Shaw had done in endeavouring to correlate some of the results obtained with cast iron. It was known that he and Mr. Shaw were not agreed as to the best methods of tackling the problem of elucidating the theory of cast iron, but he was convinced that they were both working towards the same end. He agreed with Mr. Pearce that unquestionably methods of investigations, dealing with the pure materials, were necessary, as well as practical scale tests in establishing facts. He expressed himself as convinced that the discrepancies between the two methods of experiment were not as good as Mr. Shaw made out, for the laws of Nature were unchangeable, and it was that we did not fully understand the causes governing the results that we obtained our varying effects. One day we should find that the whole fitted into a perfect structure of theory, in which all our apparently contradictory facts would find a place.

Two Types of Carbon Solutions.

Continuing, Dr. Everest said that much attention had been given that evening to the possibility of undissolved carbon occurring in molten iron, and this was put forward to explain certain phenomena connected with the properties of super-heated iron, and iron made from open pig, or synthetically. But against this we have the experiences of numerous experimenters, and Mr. Hurst had just mentioned the lack of segregation of carbon in centrifugal castings, as bearing on this point; also the absence of graphite in the drops of molten iron quenched in water in Northcott's experiments might be mentioned. An alternative suggestion had occurred to him (Dr. Everest), which he would like to mention, but he put it forward very tentatively, since he had not himself yet had time to examine it very thoroughly, to see if there were any obvious flaws in it. In THE FOUNDRY TRADE JOURNAL of October 25, 1928, there was a report of a most interesting Paper by Mr. H. A. Schwartz, in which he mentioned definite evidence of there being two solid solutions of carbon in iron, that is austenite as we know it, holding in solution either carbon as such, or as iron carbide. This suggests the idea that we may have the carbon in molten cast iron dissolved either as carbon or as iron carbide, that is there are two possible solutions. We have ample evidence of the co-existence of both forms of carbon, one stable and one meta-stable in the solidifying alloy, so why not in the molten form? If this is so, experience would indicate that the carbide solution was the more stable at higher temperatures. Once again it might be emphasised that the statement of equilibrium conditions indicate little more than conditions towards which the alloy is tending. It might be mentioned that recent experimental work, in which specimens were held at elevated temperatures for weeks, in order to obtain true equilibrium conditions in the structure, have been criticised on the ground that the specimens were not held at the temperatures for sufficiently long. So it will be appreciated that in foundry conditions, true equilibrium need not be expected, and hence the co-existence of these stable and meta-stable forms in the molten iron.

Now examining this idea further we find that it fits in reasonably well with many of the phenomena described that evening. In mixtures made up synthetically from white pig, or from normal pig chill-cast, the combined carbon in the finished castings is higher because initially much of the carbon is present as carbide, it dissolves as such on melting, and much of it comes out again as such when the iron is cast. But given an iron of pig, then the carbon exists as graphite, dissolves as such and reappears as such. While in the molten condition there is a gradual change, however, of graphite to carbide, or *vice versa*, under the influence of the tendency to attain equilibrium. He thought this might be an explanation of the high combined carbons obtained in American washed iron base castings, although in the case of these, he agreed with Mr. Pearce as regards the influence of manganese. Again, the greater strength of steel-mix cast iron was perhaps due to the higher cupola temperatures necessitated by the use of steel in the charge, this having a reflex action in tending to the greater formation of carbide-solution from the graphite solution in the molten iron. If there was anything in this theory then there was apparently a definite reason for the improvement in properties occurring in the use of chill-cast pig. This is put forward as an idea which if worked up further might lead us somewhere.

Dr. Everest then asked Mr. Shaw if the time factor did not enter into the experiments made by taking castings at temperature intervals from a cooling ladle. He suggested that different results might be obtained from a small or large ladle, owing to the different cooling rate in each case. This would have some bearing on the above theory. Finally, Dr. Everest said that he thought Mr. Shaw's remarks concerning the graphite form, controlling the mechanical properties of the iron, were somewhat unfortunate as they might lead to unnecessary confusion. They appeared to be true only up to a point, for as the graphite-form became finer, as controlled by composition, cooling rate, or by the use of alloy elements, then surely the influence of the matrix should become more in evidence. But was not this carrying our analysis too far, for in general the nature of the graphite and of the matrix are closely related. We would not expect a hard pearlitic structure to be associated with a coarse graphite, nor on the other hand would we expect a soft matrix associated with fine graphite in an ordinary sand-cast iron. The processes for producing the one in general produce the other, and fine pearlite would usually be associated with the higher combined carbons, in which case the graphite is usually in a fine form, thus both factors tend together to produce a harder and stronger iron.

Author's Reply.

MR. SHAW said that one could but admire Dr. Everest's courage in putting forward his theory. Unfortunately he was not yet able to offer proof. He had also again stated the need for investigations carried out with pure initial materials. Yet to-night we have heard from two men with scientific training that one did not, under cupola conditions, obtain the same results from a pig-iron that one did from a synthetic iron. The investigation on Fe, C and Mn showed that the last element had a definite hardening effect. This had always been taught in connection with cast iron with silicon present, and was so at a series of lectures to practical men only last year. Due to a pure accident (using a hematite, instead of pure materials), Turner, in his silicon investigation, found an arrest point that was not noticed in the later Paper by Turner and Hague, using pure materials, till 0.5 per cent. Mn was added, when the CC was reduced from 0.84 to 0.22 per cent. Mr. Pearce had stated that recent research had confirmed this. The point he wished to make was: If pure materials had been used in the first experiments, this arrest point could not have been noticed. Mr. Pearce earlier on stressed the good work done by German metallurgists, a point with which we are in agreement. At the same time nearly all this work had been done with straight pig-irons as a base. Even in the present experiments the base iron was a Swedish pig of a similar analysis to hundreds of tons that came into Sheffield each year. It was true concentrated alloys

were added to obtain certain analysis and lower the carbon. The Germans recognised, with their usual business acumen, that it would take years to investigate each combination in cast iron, hence their use of iron with all the elements present, keeping one or two constant. It is 28 years since Roozeboom published his first diagram, 18 years since Turner's investigations on C Fe Si., yet founders were debating the formation of graphite. With regard to the time factor accounting for the difference in graphitic carbon between a test taken from a ladle at 1,450 deg. C., and a second from the same ladle at 1,170 deg. C., Dr. Everest did not suggest that free graphite was again precipitated from the molten iron with a carbon of 3.0 per cent. and Si of 1.9 per cent. In Gresty's case the wedge was less than 2 oz. and was cast in a chill. Freezing would be instantaneous, and would be carried below the last change point before the chill became warm. Yet in the low temperature graphite was higher.

Vote of Thanks.

MR. WESLEY LAMBERT (Senior Vice-President of the Institute, and Past-President of the London Branch) proposed a hearty vote of thanks to Mr. Shaw for the thorough manner in which he had dealt with the subject. Commenting upon Mr. Pearce's question regarding the modulus of elasticity of the high-tensile cast irons, he remarked that the modulus of elesticity was related to the elastic properties of the metal rather than the ultimate strength. He instanced the fact that a given steel of five tons per sq. in. greater ultimate strength than another steel may yet have a lower modulus of elasticity than the latter. He had known of engineers who, having found a reference to a certain figure for the modulus of, say, a steel of 35-ton tensile strength, had raised that figure when considering a steel of 40-ton tensile strength, regardless as to whether both steels were of the same type. Such a procedure was not justifiable.

Mr. Lambert expressed the hope that there would be a further discussion of Mr. Shaw's Paper at a subsequent meeting of the Branch, or that written contributions to the discussion would be made. The subject was one which appealed to many, especially to those members interested in cast iron. He shared with Mr. Shaw his dislike of experiments based on "thimblefuls" of metal. The influence of mass played a very important part, and small quantities were not necessarily truly representative.

MR. H. C. DEWS, seconding the vote of thanks, said that Mr. Shaw's criticism of the work of Bardenheuer and Zeyen was most interesting and illuminating. At the same time, he agreed with Mr. Hurst as to the difficulty of determining just what Mr. Shaw's beliefs were; it seemed that Mr. Shaw had agreed with most of the conclusions of Bardenheuer and Zeyen, but disagreed with the manner in which they had arrived at their conclusions; in other words, he disagreed with everything that proved his points. That might be sound science, but it was poor politics. (Laughter.) Nevertheless, the criticism provoked a discussion which had been very constructive and illuminating, and the members of the Branch were thus doubly indebted to Mr. Shaw.

The vote of thanks was accorded with acclamation.

MR. SHAW, responding, said that his views were perfectly definite. Dealing further with Dr. Everest's remarks, he said he had made regularly a material consisting of steel and a percentage of a high-silicon pig, the latter to make it grey, and the structure of that material was very fine. It had not a washed-iron base, but still it was what he called a synthetic iron. Such irons were useful, but the difficulty was that one could not control them. He felt sure that with a mixture of that sort one could make stronger castings than with even a cold-blast pig-iron. Finally, he said that if he had to start his career again he would join the foundry trade, because he knew of no other trade in which there was so much interest.

THE EGREMONT URBAN DISTRICT COUNCIL have confirmed resolutions of the Rating Committee that the appeal of the United Steel Companies, Limited, in respect of Woodend Iron Ore Mine be opposed, and that the appeal of the United Steel Companies in respect of Parkhouse Mine be agreed to from the time they commenced to dismantle the mine.

Permanent Moulds for Iron Castings.

Details of the Büsselmann Process.

The idea of making moulds which can be used for more than one casting has, of course, for long occupied the minds of many practical foundrymen. In the non-ferrous foundry, metal moulds have been in use for many years for certain objects, while, in the ironfoundry, the iron mould is only applicable for special purposes.

There has been no lack of attemps to produce permanent moulds of plastic materials similar to moulding sand. In the process developed by the Büsselmann concern of Hanover, a mixture is made use of similar to that usually employed in the production of steel castings, and it is claimed that very appreciable savings in moulders and other wages can be achieved.

Constituents of Moulding Mixture.

Generally speaking, the composition of the mixture is two parts ground fireclay, two parts kaolin, one part coke, three parts quartz sand, three parts clay water, and four parts Ellriche sand (high quality green sand).

Variations from this formula must be considered in certain cases, according to the locality; for example, one may have to use up to four parts clay instead of two. The materials are ground, mixed, moistened, and then, as in the case of other moulding mixtures, thoroughly worked in an edge runner mill or other mixing machine until complete homogeneity is obtained. The backing sand employed must be somewhat fatter than usual, as otherwise, through its loosening in the flask, the mould would be rendered inaccurate. The latter would thus have to be broken up before the moulding material itself had become damaged and before it had yielded the maximum number of castings attainable.

With reasonably careful attention to the preparation of the mixture, the backing sand and the making and treatment of the mould, 20 to 30 castings can be expected from a single mould where the flask size is not more than 1 sq. metre. With larger flasks, the life is correspondingly shorter. By the addition of two to four parts of asbestos to the above mixture its permanence can be increased by 20 to 25 per cent.

No special moulding boxes, patterns or pattern plates are required, and existing equipment can be utilised. In the cases of certain castings, however, it may be necessary to employ a larger number of cores if there is danger to the mould or to the casting owing to contraction. Upon similar considerations, the openings for gates and risers are formed in a less permanent and more yielding moulding mixture. Thorough drying of the mould, through and through, is a point of great importance.

As all foundrymen are aware, when a casting produced in a loam or dry sand mould is stripped most of the mould remains intact, if only the moulding mixture was really good. To render it possible to preserve the whole of the mould and utilise it again, the chief necessities are a good moulding mixture, certain precautions against shrinkage and suitable treatment and working of the mould.

What, now, is a good moulding mixture? It consists of a moulding sand fairly rich in clay, which, employed alone, would not be sufficiently permeable to gases for moulding purposes. To give it the necessary properties, there have to be added horse manure and lean sand, rich in silica and not of too great fineness. The more intimately are these materials mixed the better is the result.

Use of Asbestos.

Things are similar in the case of the mixture for permanent moulds. Here, however, the addition of horse manure or other organic materials is out of the question, as they would be carbonised by the repeated heating and the mould would soon disintegrate. A substance having a similarly fibrous nature to horse manure is asbestos, which at the same time has the advantage of being able to withstand unlimited heating. It was found, however, in Germany, to be too expensive to receive wide adoption for the preparation of permanent moulds until a substitute for the mineral imported from overseas was found in a micro-asbestos from Burgenland, in Austria.

This is supplied of a constantly uniform quality, ground, or washed and ground, and forms in this condition a valuable constituent of moulding mixtures. Its chemical analysis is (in per cent.):—SiO_2, 49.81; Al_2O_3, 2.19; CaO, 13.21; MgO, 27.96; moisture at 120 deg. C., 3.91; Fe_2O_3, 2.80; MnO traces. This asbestos retains its fibrous nature even when in a state of the finest sub-division.

Economies Realised in Practice.

The following figures may be of interest with regard to the economic aspect of the Büsselmann process. They represent the results of the practical manufacture of a large machine frame standard or column, using permanent moulds as described briefly above.

Before the new process was adopted, a moulder and one labourer took three days for the moulding and casting of each column; thus, 24 hours' wages for both moulder and labourer had to be reckoned on each casting.

Upon the introduction of the permanent mould process, 32 hours for both moulder and labourer were required in the preparation of the new mould for the first casting, while the following nine castings were turned out in 14 hours (moulder and labourer) for each casting.

Ten castings cost, therefore:—

(*a*) With the old method:
$10 \times 24 = 240$ hrs. moulders' wages + 240 hrs. labourer's wages.

(*b*) Cast in permanent moulds:
$1 \times 32 = 32$ skilled man-hours + 32 hrs. man-hours.
$9 \times 14 = 126$ skilled-man-hours + 126 hrs. man-hours.
Total, 158 skilled-man-hours + 158 hrs. man-hours.

Thus, if the two types of labour are added together, it will be seen that the use of permanent moulds saved $48 - 31.6 = 16.4$ working hours per casting—roughly 33⅓ per cent. Further economies resulted from the lessened consumption of dressed moulding materials, as also of coke for the drying stoves. Savings in labour for the transport of materials, and in connection with conditioning, etc., were also realised.

In spite of the novelty of the process not one casting had to be scrapped in the course of several months' production of the above-mentioned columns. On account of the size of this piece, no attempt was made to get the absolute maximum out of the permanent mould, but, in the case of smaller patterns, 25 to 30 castings were repeatedly achieved in one mould.

Even where the foundry is equipped with jar-ramming machines, the Büsselmann process can be very useful for moulds which cannot be dealt with on this machine. More than this, however, permanent moulds can be employed in conjunction with jar-ramming, the machine thus being relieved, as the boxes do not return every day empty. In similar fashion are the drying stoves greatly relieved. Many moulds can be dried outside the latter in a couple of hours with the aid of a small portable oven, and are then ready for insertion of cores and pouring.—*Abridged from an article by Karl Lehmann in "Die Giesserei."*

World's Largest Excavator.

Messrs. Ruston & Hornsby, Limited, ironfounders, of Lincoln, have just received an order from the London Brick Company and Forders, Limited, for a giant, electrically-operated shovel, which will be the largest excavator employed in any brickworks in the world. A representative of THE FOUNDRY TRADE JOURNAL was informed that the machine will weigh approximately 380 tons, and will carry a 7½ cubic yard bucket and a jib 90 ft. long. It will deal with 800 tons of clay per hour for the large and up-to-date brickworks of the London Brick Company and Forders, near Bedford.

The Engineer and Founder.

At a recent meeting of the East Midlands Branch of the Institute of British Foundrymen, held at the College of Technology, Leicester, Mr. J. Lucas, of Loughborough, was in the chair.

Mr. W. H. Poole, of Keighley, gave a very interesting sketch of the foundry industry, commencing from the prehistoric age. He then proceeded to illustrate, by a number of lantern slides, the examples of early moulds, used in the Bronze Age, and declared that such stone moulds showed the importance paid by the early craftsmen to gating and venting.

Engineers might ask: "Why is there still so many troubles with grey-iron castings in these enlightened days?" but the engineer had himself to blame somewhat for the position. What did the average engineer know about cast iron? It was a great pity that every aspirant was not compelled as an essential part of his practical training to spend a reasonable period in the foundry. What the average engineer required was a casting that would machine easily at the lowest possible cost, but, of course, the casting must have no blemishes. The primary concern was price, a matter which was often overlooked if he had a foundry of his own. The last point considered was the metal quality, a factor entirely out of keeping with the exacting requirements of modern engineering practice. It was, however, a point of the utmost importance to the up-to-date engineer fully to study the requirements of grey iron practice, as it affected his product. Steel and its development, stringent demands of the engineer and the great technical and scientific study associated directly with practical production of steels of so many types and properties, gave a fine example and justification of the combined efforts of the steelmaker, the engineer and the metallurgist. Cast iron was a material which, if properly controlled and handled, was capable of greater service, utility and uniformity, than was too often the case to-day.

Undoubtedly the engineer should show more interest in the foundry and help to mechanise and render able that side of the job as they did the machine and tool-room work. They ought to aid the founder to procure better tools, modern handling facilities, better structural buildings and ventilation, and to keep the foundry end of his job as up-to-date as his own shops. Too often was the foundry sadly handicapped by crude and out-of-date plant, cupolas which should be scrapped, and a shop generally behind the times. As the machine shop depended on the foundry, it would be readily appreciated that increased efficiency in the foundry would prove an asset to the engineer. In no craft were there so many variables, and probably the engineer realised that the foundryman had many reasons why castings should be wasters, and often so few reasons why it should have been correct.

Defects from the Mould.

Amongst common defects were misruns, cold shuts, scabs, contraction cracks, spongiiess, cross joints, cores broken, and numerous others. The efficient examination of foundry wasters was one of the secrets of foundry success. There was obviously a reason for every waster, and they should profit by their faults. Wasters should be examined with care and intelligence, and the metallurgist could aid the founder in the control of this foundry work.

How the Metallurgist Helps.

The classification and control of raw materials used in the foundry was becoming more important. Pig-iron was of many types and qualities. The purchase was often largely governed by price, and the result was that often iron was bought in the cheapest market, irrespective of utility for any specific jobs. Often, pig-iron varied batch by batch. Those founders who purchased to some specification were likely to be better served than with less defined purchase. To buy pig-iron to-day on a "number" basis was inadequate, and so was the method of buying to a fracture test. Considerable trouble in foundries was caused by lack of appreciation of just the grade and type of pig desired, and the pig-iron suppliers being quite in the dark as to the grade required for the work being made. Some blast furnaces would grade No. 3 pig into sub-grades, varying in fracture and analysis, and so in utility. It was possible to have a No. 3 iron with a very open fracture, and also with a close fracture, varying particularly in total carbon and sulphur, and silicon. Untold worry was given the founder by lack of appreciation of this aspect of pig purchase. Founders should know the grade they required, and thus be able to order a similar type if found satisfactory, and give some specification of analysis. It was not suggested that to-day pig-iron generally was of poorer quality than pre-war, but it was considered that, in these days of commercial stress, pig production required every care in grading more precisely than ever, as it concerned foundry purchase and usage. Some pig suppliers were more careful than others, and one could very soon check their attention by analysis tests on delivery. The more such a demand came from the purchaser, the more care would be exercised at the furnaces. To-day pig-iron suppliers were alive to the need of better grading, and would give service if at all encouraged. When pig was ordered as No. 3 and nothing further they could expect, at some time, trouble with the foundry work and the pig blamed, whereas bad ordering was responsible. There was really little bad pig, but there was much pig-iron of a wrong type, and analysis wrongly used for the job. So long as engineers were content to order castings without any stipulation as to metal quality for specific jobs, so long would founders be able to supply castings that varied in quality, but would pass a machining test with more or less variation, and be of doubtful and varying strength. As with pig-iron control, so with all raw materials—scrap, sand, refractories, plumbago, coal dust, etc., could be investigated before usage. The procedure of investigating faults from materials after the castings were made was obviously wasteful—a waste that too often extended to the machine shop. For instance, they could take the case of casting finish, the skin effect and the complaints from the machine shop of tools failing. Sand control, and particularly systematic attention to the floor condition, would greatly improve matters. One could not help being impressed by the attention given to the sand question by continental foundries. Generally speaking, insufficient care is given to the cleanliness of the sand, the foundry floor, to systematic mixing, and to the handling of this important material. Founders should store the sand in suitable bins under cover and away from the influence of dust and dirt. When new sands were stored, as was often the case, near the cupola, with dust and dirt contaminating the stock, could one wonder at a bad skin effect? What would happen if one had outside storage where rain could wash out the bond? Yet, too often, some obviously simple care was lacking in such points. Moreover, as the foundry floor was so likely to be contaminated with slag, metal globules, scum and dirt, it necessitated some systematic attention. Why did they so often see such untidy foundry floors, accumulation of months left until, ultimately, necessity called for usage?

Tests of Foundry Floor Sand.

Simple tests of the foundry floor sand for silt content—the fine flour grade that clogged the sand—could be made. A test for bond which everyone could do was by shaking up a standard amount of sand in test tubes of uniform section. This would give a weekly bond comparison very useful to the man in charge. An interesting "interbreeding" effect took place in sand usage, and also in metal mixing, that baffled the unthinking foundryman. It might take days and weeks for an effect to develop, and ultimately it became a disease. They should not, however, be misled, for example, from the use of the first trial of a sand mix or even a metal mix; they should watch carefully the accumulative effect of the alteration. The law of averages so balanced things that this explained how one could often get through, but a deeper study would often give them the knowledge to sense what was coming.

Foundrymen should purchase to some defined analysis limits, especially silicon, and total carbon. They should not order to number alone, but specify if open, close or hard fracture. They should store according to batch numbers with record of delivery for reference. They should examine purchase for oxidised, dirty or inferior burnt scrap, and especially chemical works' scrap and corroded pipe scrap. Classify domestic scrap if mixing to analysis and type, and make the most use of special scrap. Coke should be stored under cover and always examined for physical condition. Sands from the same pit varied for bond, grain, size, etc. It is desirable always to carry stocks of both open and bonded sands to correct the sand mix if desired.

For successful cupola operation the following should be kept in mind: Weigh metal charges on principle. Do not charge sand into the cupola. Scrap should be kept clean. (Sand-blasted scrap had been known to pay.) Flux should be used with due regard to the charge condition, and limestone (calcium carbonate)—a base—if it contained excess silica, the amount of its flux and capacity was lowered. Pure limestone should be used, as silica was sand and would not "flux" the metal. Efficient fluxing was a vital point. They could not expect clean melt if they used poor quality or an excessive quantity of ganister for patching. Ganister was silicious, and would form slag. The cupola should be kept in good trim inside, and the zone formation should be controlled to be kept uniform. Good refractory bricks would, when suitably glazed, give a long life, but, if ill-used they would flux quite rapidly. Bricks could be tested before use as well as ganister. In cupola working it was the air volume that counted.

The average founder did not know what volume of air he was using. Every cupola should have a volume control. The metal should be charged uniformly, using suitable charge-weight for the furnace capacity. Tapping should be arranged to collect, if possible, a charge in the well, in order to get good blending. Many were afraid of slagging the cupola sufficiently often. One should use a receiver for shops where metal storage was desirable, and examine the slag for pellets and test for the iron content occasionally. The colour was some indication of the flux reaction. Metal should be melted as hot as possible and cast at the temperature to suit the jobs, not the mould condition.

Higher Quality Metals Demanded.

They were passing from the day when soft phosphoric irons were largely used and engineering demanded higher quality metals. The practice of using one mix for castings of wide variation of weight, shape and section was likely, at some time, to give trouble, unless special precautions were made to meet this, such as use of denseners on heavy bosses and adequately feeding heavy sections. The use of more than one mix was advisable where there was wide variation of mass and shape of castings. Grey soft iron ran dirtier than a hard mix. If metal appeared hot and yet chilled off rapidly, blowing and charging should be investigated. Spongy black coke would give trouble with dirty metal. If ladles were skimmed at the spout it encouraged care elsewhere, and cleaner ladles for casting. The human element would, if not controlled, spoil good moulds with dull iron. Men must be trained to think before they filled the moulds. The metal should be skimmed at the mould by using a skimmer. The mould runner formation should be controlled; some runners asked for dirt to "suck" into them. Round bushes for runners were not good practice.

Sand Mixing Plant.

Every founder who wishes to keep pace with the times must study his sand handling and mixing plant, for in this direction much trouble could be eliminated. One had to consider sand mixings to suit varying jobs, as well as such factors as bond, permeability, refractoriness, and so on. The uses of coal dust, blacking, plumbago, etc., demanded control. Coal dust could be of different

grades; it contained from 5 to 65 per cent. ash, and, with qualities varying so much as to account for defects ranging from pock marks to misrun castings. It was easily possible to conduct laboratory tests in conjunction with foundry tests to ensure control with such material. Mould cleanliness and careful use of facings, venting and suitable sand refractory condition were all points of importance. Oil-bonded sand having various types of bond was to-day of almost universal use. The manipulative skill learnt by long practice in the moulding art taught, as did no other method, the many points of importance in mould making. The degree of ramming, care in sleeking, caution with the water pot, when the moulds required support with efficient use of gaggers, etc., were all points that got rooted in the mind of the efficient craftsman.

The need of initial co-operation between the designer, patternmaker and founder could not be over emphasised. Particularly did that refer to production of repetition work, where time spent on the study of the job at the beginning would save itself amply afterwards. Trial of cast-off plates for strain, cleanliness, solidity, etc., could be made. All foundrymen, no doubt, were aware of the spasmodic results often found where some weeks or months of good castings were made—and then trouble. This often recovered, but the exact cause was sometimes not traced, or, perhaps, the exact reason of how the trouble was corrected. Scientific thinking and investigation into such troubles would correct the cause and effect much quicker than trial and error.

Discussion.

MR. HALLIMORE instanced a case of where a cupola had been working on two tuyeres for many years, this difficulty having arisen owing to the position of the cupola in the works. To his mind this was unsatisfactory owing to the uneven distribution of the air, and he would like to know if Mr. Poole could suggest a remedy without the firm in question having to move the furnace or pull down a wall.

MR. POOLE said he had seen cupolas "blown" in some weird ways, and mentioned that, in an article he had read, the writer had stated that some cupolas were being worked to-day that had been in use up to 100 years. All kinds of cupolas were referred to; in fact, the writer had stated that, even the funnels of old ships had been used. The writer even went so far as to say that they were doing better than some of their modern brothers to-day. However, in answer to Mr. Hallimore, he could say they could blow with two, but they could blow much better if the air was distributed in a proper way.

MR. PEACE (Derby said his opinion was that what the engineering trade required to do was not so much to improve the cast iron, but to improve the castings. Scientific people to-day were continually trying to get an iron to overcome all physical defects. He had not the slightest doubt that most of the defects were attributable to the cores.

MR. POOLE said, with regard to improved cast- and not improved iron, as suggested by Mr. Peace, he would say that most foundrymen would tell them that if the iron was improved the castings would be satisfactory. If a man was trained to think he would be all the better for it. Only last week he visited three works and was quite amazed at the cleanliness in the foundries. In one Manchester foundry he did not see a barrowload of sand out of place, and whilst in Yorkshire he saw one that was exceptionally clean; in fact, he had never seen one so clean before. Obviously the conditions that prevailed were excellent.

MR. S. H. RUSSELL (President of the Institute), in proposing a vote of thanks to Mr. Poole for his very interesting and instructive address, said it had been thoroughly enjoyed, and was worth going a long way to hear.

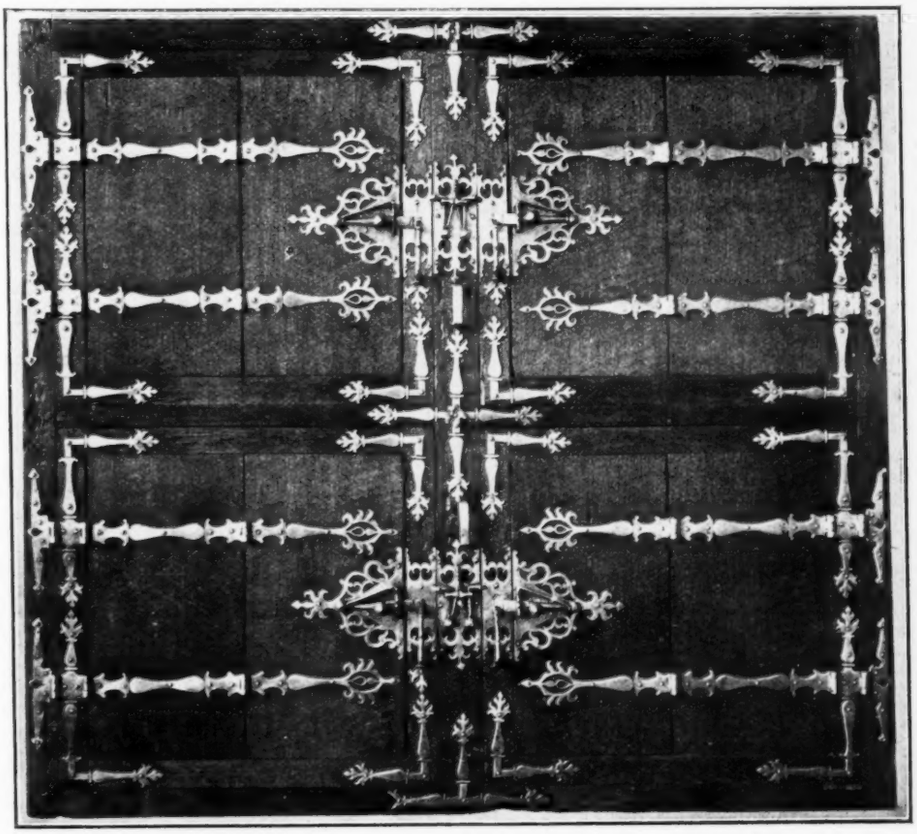
MR. A. S. CLARKE, who seconded, said he happened to be one of the unfortunate engineers. What they required to-day was greater co-operation between the patternshops, the drawing office and so on, and then there would be better conditions. There was no doubt there were better days in store even now, as the educational facilities that were offered were excellent, and much different from his youthful days. Lectures, such as the one they had heard that night, helped to fit them for better positions, and so much knowledge had Mr. Poole imparted that he hoped he would speak to them on some other occasion.

MR. POOLE suitably replied, and was loudly applauded.

Sixteenth Century Shutter Ironwork.

Shutters of wood with more or less ornamental decorative ironwork to form a support for the doors swinging on the hinges have been in use in England for many centuries.

As civilisation has advanced, the domestic shutter has tended to disappear in this country, but not in France. Now it is interesting to pursue an inquiry as to the form commonly exhibited by the metal attached to the shutter 400 or 500 years ago. It is at once clear that the ironwork, starting originally as little more than the hinge proper, soon became a dominant feature of the shutter. As the ironwork left the hinge it spread as a mass of scroll work over the timber of the shutter, and supported by its different members every board.



A SIXTEENTH CENTURY SHUTTER.—REPRODUCED BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM.

As specimens of wrought ironwork, many of these hinges of the past can claim a high degree of artistic distinction. Those shown in our illustration exhibit some degree of care in design, and certainly excellent craftsmanship in execution. Without being of any exceeding beauty they are pleasant to look on and effective in purpose; they are said to date from the 16th century. For the illustration we are indebted to the Director of the Victoria and Albert Museum.

Australian Steel Bureau.

Representatives of the ten firms associated with the Bureau of Steel Manufacturers of Australia met in Sydney recently for the annual meeting of the Bureau. During the period of the meeting members inspected the principal industries at Port Kembla and were also conducted over the workshops of Dorman, Long & Company, and the construction work of the Sydney Harbour bridge. Mr. Cecil Hoskins, managing director of Australian Iron & Steel, Limited, was elected president for the ensuing year. Mr. Leslie Bradford and Mr. Essington Lewis were elected vice-presidents. Mr. W. Burrowa was re-elected secretary. The annual report stated that good progress had been made by the sub-committee of the Standards Association, upon which the Bureau has representation. The president of the Bureau (Mr. Essington Lewis), in his review of the past year, pointed out that an event of considerable importance to the industry was the formation of the organisation known as Australian Iron & Steel, Limited. It was possible that on the next occasion that Sydney was the scene of the annual conference, in 1931, only the finishing touches of the harbour bridge would remain to be done, and he suggested that the British Iron and Steel Institute, and also the American Iron and Steel Institute, should be invited to hold their annual meetings in Australia in that year.

The extensive plant which is being installed at Port Kembla by Australian Iron & Steel, Limited, was inspected by members of the Bureau, who were also shown the Company's coal mine at Wongawilli, which will be called upon to produce sufficient coal to make the 700 to 800 tons of coke that will be used daily at the blast furnaces. The first unit of the blast-furnace plant was set in operation recently, and marks the entry of the firm on pig-iron production at Port Kembla. Two open-hearth furnaces, a 42-in. blooming mill, and a 36-in. reversing finishing mill will comprise the initial units.

THE EMPLOYEES OF MESSRS. D. & J. Tullis, Limited, Clydebank, have contributed £225 during the year to West of Scotland Charities.

System in an Iron Foundry.

By M. E. Nicholls.

It is one thing to have modern equipment in the foundry, but quite another thing to know how to make the best use of it. Most foundrymen know what equipment is necessary for their requirement, but comparatively few succeed in satisfying the requirement, even though they have the necessary equipment.

The fact is that system must be employed if the best results are to be achieved, for although there may be adequate equipment on the one hand, and plenty of orders on the other, it does not follow that expectations will necessarily be realised, either in regard to quantity or cost. There must be systematic procedure at every stage, from the reception of the order to the despatch of the finished castings, and although some foundrymen assert that one can accomplish anything if only one works hard enough, the fact is that much more can be accomplished by systematic procedure, and with considerably less effort.

One of the most important features of modern production is the planning of the day's work in advance, for if it is known just what has to be done, there is a greater probability that it will be done. But it is of no use planning for an output of (say) 20 tons of castings without carefully considering the factors involved, and of these two stand out prominently, viz., the requirement, and the cost of production.

The requirement is exemplified by the foundry's commitments, specified delivery dates and customers' speed-ups, and so, assuming 20 tons to be the daily capacity of the foundry, that 20 tons must be comprised of castings for orders scheduled for completion within the next few days. And here is the first instance of the value of systematic procedure, for it must be known just which orders are to be taken in hand. The foundryman does not pick up a bunch of orders at random and say they will do for to-day, but it is a fact that some of them do come perilously near to this, for owing to lack of system the commitments are not properly collated, and often orders are taken in hand in date sequence, without regard to specific requirements, together with those orders which are being specifically urged by customers because they are overdue.

If work proceeds on systemised lines, the latter contingency should arise only at very rare intervals, for customers' requirements are anticipated, and the castings are made and despatched in accordance with the delivery date appearing on the order. In this connection, however, delivery dates should not be accepted by the foundry unless it is known that there is a reasonable chance of meeting them. If the date appearing on the order is too short for the foundry to make and deliver the castings, the customer should immediately be communicated with, and a new date given, this taking into consideration previous commitments. And this means that the extent of his commitments must always be known to the foundryman, a matter of impossibility unless systemised procedure is in operation.

Many customers have a knack of inscribing all orders, "Delivery in three days (or one week)," and at the end of this time they begin to send along "Urge notices." They do not really want the castings at that time, neither do they expect them, but it suits them to badger the foundry because delivery is behind time, and the best way for the foundryman to safeguard himself is to repudiate these automatic deliveries immediately the order is received, and give a reasonable date which can be embodied in his production schedule.

The other outstanding factor in planning the day's work is the cost of production. One specific unit of equipment may be admirably suited to certain purposes, while being only moderately successful when applied to other purposes. Every unit therefore must be classified in accordance with its utility, and every effort made to supply it with the job it can successfully undertake. It is essential that every casting should be produced at the lowest possible cost, and if, in respect to a certain type of casting, it can be produced more cheaply by one method than by another, then obviously the cheaper method must be employed. It may be that in some instances one unit of equipment is overloaded with work while another has barely sufficient for its capacity, and in this case some adjustment is necessary. But it must be known how that adjustment can best be effected, otherwise it will be found that, although the day's production has satisfied the requirements, the cost has in many instances been enhanced.

It is necessary to have everything in readiness for the day's work, so that there is no unproductive waiting time. The programme and the work orders must be in the hands of the foremen concerned early enough for them to consider and appreciate what has got to be done. Patterns must be available immediately upon demand, and they must be in a fit state for work. In some foundries a good deal of time is wasted, first in locating the pattern, and then in effecting minor repairs, usually rendered necessary by rough treatment in the foundry. As soon as a customer's pattern comes to hand it should be examined, and if in working condition should be placed in the pattern store, the precise location being duly recorded. If damage has been done in transit, this should be made good before the pattern is placed in the store. When the castings have been made the pattern should again be examined, and any defects remedied, and then, if it is to be retained, it is once more placed in the store and the location recorded, while, if it is to be returned to the customer, it is sent to the despatch department, and a record made to this effect.

It is inevitable, of course, that some little expense will be incurred in carrying out this procedure, but this expense will be more than covered by the saving effected by the abolition of waiting time in the foundry, which is an expense which yields no return, and is therefore money wasted, which has to be added to the cost of production.

Production costs are enhanced by waiting time, and if for any reason production cannot proceed immediately the facilities are available, either the job must be put back and taken in hand again later, thereby delaying the completion of the order, or the men must remain idle until such time as the impediment is removed. Sometimes part of the work in connection with one job is handled in two or more sections of the foundry, and this means that these sections must be co-ordinated, so that one does not have to wait for another. For example, moulding is delayed if the cores are late, and it follows therefore that the coremaking section must be time-fixed to permit of the cores for a specific job being ready by the time the job is due to be taken in hand. A simple progress system, devised to meet the specific requirements of the foundry, is valuable for effecting co-ordination between the various sections and ensuring that no delay will arise consequent upon one of the sections failing to meet its commitments.

The true production cost of every casting (or in some instances batches of castings) should be known, and the workmen should book on and off each job, as is done in other branches of engineering, care being taken to see that the production jobs are continuous, so that the whole of each workman's time is accounted for. Thus, when one job is finished, the workman books off this and straightway on another, which means that there must be another always available. It is when there is no definite means of ascertaining when a man begins or finishes a job that costs are enhanced because, although maybe he has at the end of the day contributed his quota to the productive output, it is not possible to determine whether the cost of any one job has been exceeded, or whether his contribution to the day's output represents the limit of his capacity.

System should operate in the fettling shop, and the early inspection of all castings is also desirable. The fettling shop is a productive department, but where there is no system it is often an expensive department. The inspection of castings should be early enough to preclude the possibility of unnecessary work being done on a defective casting, and early enough to enable the inspector to fix responsibility when bad workmanship is the cause of rejection.

All castings should be finally inspected just prior to despatch, so as to avoid sending out castings which will be returned by the customer as defective. Care must also be taken to ensure that castings are not sent to a wrong destination. This is not an every day occurrence, but it does happen from time to time, and causes a good deal of annoyance and expense. The despatch man should be furnished with detailed instructions which will enable him to identify the castings with the customer in every instance.

System is really necessary to the well-being of any foundry. It need not be elaborate, but it must be efficient and sufficient, and accelerate production instead of retarding it. Some foundrymen aver they can move more swiftly without system, but they are usually confusing system with red tape, which is a vastly different thing. It is obvious that methodical movement is more advantageous in every respect than the haphazard, for it is definite and reliable, and ensures the maximum results for a minimum of effort.

Derby's Imported Labour Troubles.

Although there is an appreciable improvement in trade in Derby, and especially so far as the foundry industry is concerned, there are still a large number of men unemployed, including labourers. Each week local employers as well as the authorities are succeeding in absorbing a number of workless. At the same time, however, there has been a big cry over "outsiders" sending men to Derby employers who are strangers, and have no claim whatever on the town, when, as a matter of fact, there are still many idle men in Derby who could fill these positions. The question was referred to at the Police Court when the Derby Guardians made a strong protest through one of their officials. It was stated that £14,000 had been spent in relief of unemployed men in the past year, and £276,000 since the war.

Mr. A. W. Bewley, assistant clerk to the Guardians, applied to the Bench for an order of removal, so that a man and his wife might be transferred to the Pontypridd Union. The man was sent by the Employment Exchange to take work as a labourer at a Derby foundry, and, owing to certain circumstances he was discharged with another man. The man and his wife were now out of work, and had made application to the Guardians. The man said he wanted to get back to Wales, but had no means to pay his fare. He was chargeable to the Union. Mr. Bewley pointed out that the Guardians deprecated the sending of men to Derby employers if the sending of such men meant that they were given work to the exclusion of Derby men, who had to recourse to the Guardians for aid when they themselves were discharged and became chargeable. He did not mean to say that there ought not to be facilities for returning such cases to the employment exchange of their own town, but in the meantime the Derby ratepayers were saddled with the burden of supporting them.

The magistrate granted the application.

New Steel Plate Mill in Canada.—The mill of the Dominion Foundries & Steel, Limited, at Hamilton, Ont., is now to begin rolling steel plates. The mill represents a total investment of $2,000,000, but has been allowed to remain idle since the war, although the Company has been operating its foundry with an increasing volume of business. Enhanced demand for steel plates in Canada and higher prices prevailing in the United States led the management recently to put the finishing touches to the mill and to seek orders for plates in Canada; these orders having been received now, and the mill by this time is in operation. The mill is of the latest high-speed type, both mechanically and electrically, and is equipped to roll universal flats and slabs from 6 to 40 in. wide, sheared plate up to 66 in. wide, and carbon or alloy blooms and billets for re-rolling or forging.

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Trade Talk.

THE SHOTTS IRON COMPANY, LIMITED, are now preparing to blow in another blast furnace at the Shotts Iron works.

MESSRS. WILLIAM BAIRD & COMPANY, LIMITED, have blown out the three remaining blast furnaces at the Gartsherrie Works, Coatbridge.

THE EXECUTIVE OF the Iron and Steel Trades Confederation has discussed the question of the safeguarding of iron and steel, and has resolved, it is understood, that an inquiry into the subject is desirable.

THE GRANGEMOUTH DOCKYARD COMPANY, LIMITED, have obtained an order for a twin-screw passenger and cargo steamer, about 240 ft. in length, intended for service at the Straits Settlements. She will be fitted with oil-fired watertube boilers.

JOHN MURDOCH, a steelworker employed by Messrs. David Colville & Sons, Limited, at their Clydebridge Works, Cambuslang, was instantaneously killed on Friday. A seven-ton ingot slipped from the crane dogs and pinned him beneath it.

VICKERS (AVIATION), LIMITED, a company owned entirely by Vickers, Limited, have acquired all the share capital of the Supermarine Aviation Works, Limited. The last-named concern will continue as a separate company with the same personnel as before.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have received an order from Messrs. Larrinaga & Company, Limited, Liverpool, to build three cargo steamers each of 9,000 tons deadweight. Messrs. David Rowan & Company, Limited, Glasgow, will supply the machinery.

MESSRS. SCOTT'S SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, shipbuilders and engineers, Greenock, have received an order from Messrs. J. & J. Denholm, Glasgow, to build a cargo steamer of 5,400 tons for the Park Line. An order for a similar vessel was placed with Messrs. Scott's by the same owners last month.

THIS YEAR the shipping passing in and out of the Clyde is 1,153,000 tons in excess of last year, and totals 13,490,000 tons, which is a record figure. During the year the revenue from dues levied by the Clyde Lighthouse Trustees amounted to £19,038, £914 more than last year.

MESSRS. RUSTON & HORNSBY, LIMITED, Lincoln, have received an order from the London Brick Company and Forders, Limited, for an electrically-operated shovel which will deal with 200 tons of clay per hour. The machine will weigh approximately 380 tons and will carry a 7½ cub. yd. bucket and a jib 90 ft. long.

AT A MEETING of the Tyneside Development Conference, Sir William Noble stated that he had written to one of the largest banks asking them to send a man to look over the Newburn Steelworks, in order that they might know whether or not it was possible to make a commercial success of the works. He did not despair of something being done to save Newburn.

A PROPOSAL IS TO BE CONSIDERED by the Sheffield Chamber of Commerce to form sectional groups of members, who will be supplied with special information with regard to the possibilities of developing trade with specific markets overseas. Facilities will be provided for a closer study of overseas markets, and the members organised to enable them to resist more readily any attack made upon their trade.

THE STAFFORDSHIRE EDUCATION COMMITTEE has approved recommendations for the provision of additional accommodation at the North Staffordshire Technical College. The plans provide for additional buildings comprising mining laboratory, electrical laboratory, mine-machinery room, heat-engines laboratory, library extension, geological laboratory, and mine-planning room, together with classrooms, common rooms, etc.

MESSRS. ALEX. TURNBULL & COMPANY, LIMITED, valve makers, St. Mungo Works, Bishopbriggs, Glasgow, have appointed Steam Plant Accessories, Limited, 38, Victoria Street, London, S.W.1, E. E. Baker & Company, 9, Albert Square, Manchester, and Mr. Jas. W. Wilkinson, 14, Hammond Drive, Erdington, Birmingham, to represent them in the London, Manchester and Birmingham districts respectively.

MESSRS. VICKERS-ARMSTRONGS, LIMITED, have received an order for three sets of endless-rope haulage gears arranged for driving by electric motors. The fleeting wheels are fitted with renewable cast-steel treads and are driven by combined worm and spur reduction gears. The capacity of each haulage is 600 tons at 75 ft. per min. The three equipments are complete with tension terminals, haulage carriages and enclosed runway, together with the steel haulage ropes.

THE DETRICK ARCH COMPANY, LIMITED, Sentinel House, Southampton Row, London, W.C.1, announce that they have taken over from the Underfeed Stoker Company, Limited, all the rights for the design, manufacture and sale of flat suspended arches and roofs and furnace walls constructed under the patent rights of the M. H. Detrick Company in Great Britain and the Dominions (excluding Canada). They have also acquired the rights of design, manufacture and sale of Beco boiler baffles for the same countries.

NOTWITHSTANDING THE LONG DELAYING of the dismantling operations and the strenuous efforts which have been made by the local committee to save the High Yard Works of J. Spencer & Sons, Limited, Newburn, it is understood that, owing to the poor response to the appeal, Messrs. Thos. W. Ward, Limited, Sheffield, will now proceed to dismantle the plant and to make arrangements that will tend to the best development of the property. The complete closing down of the High Yard Works will extinguish all hopes of running the works, unless they can be adapted for some other industry.

THE CLAYTON DEWANDRE COMPANY, LIMITED, which has been formed to acquire and carry on as an independent business the motor engineering section of Clayton Wagons, Limited, together with certain plant and machinery belonging to that company and to Clayton & Shuttleworth, Limited, invited subscriptions on Tuesday to an issue of 175,000 £1 ordinary shares and 175,000 deferred shares of 1s. each. The purchase price is fixed at £170,000. The directors of the company are Messrs. C. H. Dade (chairman), C. T. Blacklock (managing director), R. M. Grant, W. H. Johnson, and Major H. O. D. Segrave.

AT THE ANNUAL MEETING of the Swansea Metal Exchange, on December 4, Mr. Frank Rees, of the Llanelly Steel Company (1907), Limited, was unanimously elected President in succession to Mr. Frank Gilbertson, who has resigned owing to ill-health. In a review of the iron and steel trade, Mr. Rees said that the future was far from rosy. France was now exporting more steel than Great Britain; Germany was regaining her pre-war position in the export markets, and Belgium was exporting nearly three times the tonnage she sent across the seas in 1913. Great Britain alone showed a decline in her exports. Touching upon the Anglo-American tinplate agreement, two definite advantages accrued—the stopping of unnecessary price-cutting in certain world markets, and the guaranteeing to South Wales of 70 per cent. of any increase that might occur in the tinplate demand in the markets of the world.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, Victoria Station House, Victoria Street, London, S.W.1, have recently received orders from the Continent for the following machinery:—One open-hearth furnace-charging machine of 1,500 kgs. capacity for the Société Anonyme des Forges et Aciéries du Nord et de L'Est Valenciennes (Nord); one 3½-ton guided ingot-stripping machine for the Società Anonima Acciaierie et Ferriere de Novi Ligure, Genoa, Italy, also one 3½-ton vertical ingot-charging machine; one horizontal slab-charging machine of three tons capacity for the Società Anonima Acciaierie et Ferriere Lombarde, Milano, Italy; two open-hearth casting ladle dryers, fired by blast-furnace gas, for the Sociedade Anonima Altos Hornos de Viscaya, Bilbao, Spain; one combined coke-pushing, coal-levelling and door-extracting machine, one coal-charging larry with special coal-agitator device, one combined coke guide and door extractor, and one coke-quenching car, to the order of the Successors of the Otto Coke Oven Company, Manchester, for the Imperial Continental Gas Association for their works at Vilvorde, Brussels.

SPEAKING AT THE ANNUAL DINNER of the Manchester and District Iron, Steel and Allied Trades Bowling Club, held on December 1, at the Engineers' Club, Manchester, Mr. E. J. Fox, President-elect of the National Federation of Iron and Steel Manufacturers, and managing director of the Stanton Ironworks Company, Limited, said there were signs that in this country the heavy basic industries were turning the corner. All over the world there had been over-production of coal. Whether the right way to deal with the problem of over-production was to allow the weaker concerns automatically to go under through the operation of natural law, or to use artificial means in dealing with the less economic collieries, was a question very difficult to answer One-outstanding point was royalties. Minimum rents were heavy, and in order that they might be covered producers tried to get the maximum output. In that respect Germany, with nationalised royalties, had the lead. Pig-iron could be made here cheaper than anywhere else except India, and no foreign pig-iron was coming in. Yet consumers were not consuming. What the remedy was he could not say. One thing was plain, that in these basic industries labour costs was an important factor. In Germany wages had been gradually rising, but even now the comparative figure was only 75 against England's 100. In the Saar the figure was 67, in France 50, in Belgium and Luxemburg 45.

Contracts Open.

Grahamstown, S.A.—Supply, delivery and erection of centrifugal pumps, motors and cable, for a local undertaking. The Department of Overseas Trade. (Reference A.X. 7187.)

Grahamstown, S.A., January 22.—Water meters, etc., for the Municipality of Grahamstown. The Department of Overseas Trade. (Reference A.X. 7184.)

Moniaive, January 14.—Construction of 340,000 gall. reservoir and the supply and laying of 1,255 yds. of 4-in. cast-iron pipes, for the Thornhill District Committee of the County of Dumfries. Mr. W. C. Euston, 183, West George Street, Glasgow, C.2. (Fee £2 2s., returnable.)

Plymouth, December 19.—3,300 yds. of 24-in. dia. cast-iron gas main pipes, etc., for the Gas Committee. Mr. F. Blackburn, Gasworks, Devonport.

Rochdale, December 19.—Supply and laying of about 6,000 yds. of 12-in. cast-iron gas mains, for the Town Council. The Engineer and Manager, Gasworks, Dane Street, Rochdale.

Sleaford, December 31.—Cast-iron water mains, for the Sleaford Rural District Council. Mr. E. H. Sills, Council Offices, Northgate, Sleaford. (Fee £1 1s., returnable.)

New Companies.

Godfrey Engineering Company, Limited.—Capital £60,000. Director: A. Godfrey. Solicitors: Pinsent & Company, Birmingham.

Eaton-Williams & Cleworth, Limited.—Capital £1,000. Engineers, etc. Directors: H. Eaton-Williams (secretary), 196, Ferme Park Road, London, N.8; and A. B. Cleworth.

Ubique Construction Company, Limited.—Capital £100,000. Public works contractors. Solicitors: Kenneth Brown, Baker & Baker, Lennox House, Norfolk Street, London, W.C.

Brecknell, Munro & Rogers (1928), Limited.—Capital £75,000. Ironfounders, engineers, etc. Directors: A. H. Downes-Shaw, 1, Upper Belgrave Road, Clifton, Bristol; P. V. Roberts and R. M. E. Reeves.

Blanchard & Company (Engineers), Limited.—Capital £1,000 in 990 £1 4 per cent. non-cumulative preferred ordinary and 200 1s. deferred shares. Ironfounders, etc. Director: H. Blanchard, "Fairview," Brighowgate, Grimsby.

H. M. Fisher & Company, Limited.—Capital £6,000. Constructional and mechanical engineers, etc. Directors: R. B. Davison, 31, Albert Court, Kensington Gore, London, S.W.; R. McEwan, H. M. M. Fisher and E. Thornton-Fish.

Detrick Arch Company, Limited.—Capital £1,000. Designers of combustion chambers, etc. Directors: E. W. Robey, J. K. Mann and L. H. Hosbeen. Solicitors: Maxwell, Batley & Company, 44-46, Leadenhall Street, London, E.C.

Personal.

MR. HENRY J. RHODES has been elected chairman of the Scottish Tube Company, Limited, in succession to the late Mr. Andrew Eadie.

MR. ROBERT FINNIE, manager of Messrs. Henry Balfour & Company, Limited, Durie Foundry, Leven, has retired after 57 years' service with the firm. He has been presented with a lounge chair and a wallet of Treasury Notes by his colleagues.

MR. AND MRS. JOHN M'PHERSON celebrated their golden wedding on November 29, having been married on that day in the year 1878, at Falkirk Manse, by the late Rev. Dr. Begg. Mr. M'Pherson has been in the employ of the Carron Company for over forty years.

Wills.

ROWAN, DAVID, shipowner, Dunskaig, Ayr	£130,278
BLAKEMORE, D., of Messrs. D. Blakemore & Sons, Limited, metal workers, Coventry	£16,850
WOLFE, W., chairman and managing director of Henry Hollingdrake & Son, Limited, ironfounders, of Stockport, and president of the Manchester and District Ironfounders' Association	£10,163
WILKIE, ALDERMAN A., general secretary of the Ship Constructors and Shipwrights' Association, the first Labour M.P. in Scotland	£11,225
KIRK, THOMAS, of Oaklea, Darlington, director of the Carlton Ironworks, Middlesbrough, until taken over by Pease & Partners, Limited	£42,891
WARNER, ALFRED WILLIAM, of Suddenham Road, Ipswich, engineer, of Messrs. H. Warner & Son, heating engineers ...	£20,519

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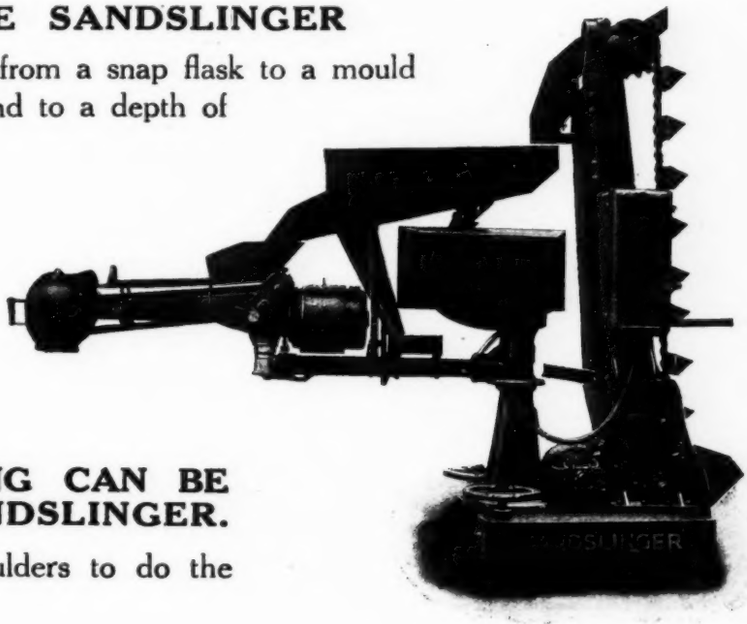
will ram moulds of any size, from a snap flask to a mould the length of your foundry and to a depth of 10 feet.



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ALL YOUR RAMMING CAN BE DONE ON A SANDSLINGER.

Keep your high-trained moulders to do the really skilled work.

Greensand and Drysand moulds are being rammed by Sandslingers and producing castings correct to pattern size.

Sandslingers are producing castings up to 40 tons.

ECONOMY.	Floor Space.	Two or three castings are being made on the same floor space required for one hand moulded.
ECONOMY.	Time.	Riddling, filling and ramming in one operation at 5 to 10 cubic feet of sand per minute.
ECONOMY.	Cost.	Sandslingers are ramming up jobbing moulds in minutes compared with hours by hand ramming.

Sandslingers will make Larger Profits for You or Your Competitor.

BRITISH MANUFACTURE THROUGHOUT. SEND FOR CATALOGUE.

FOUNDRY PLANT & MACHINERY LIMITED,

100, Wellington Street, GLASGOW, SCOTLAND.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—As might be expected within a fortnight of the Christmas break, business in the Cleveland iron markets has been even slower than usual during the week current, buying having been almost entirely confined to small lots to meet immediate emergencies, just sufficient to absorb the restricted outputs of the few furnaces now in operation. The outlook for the coming year, however, is regarded as much more favourable than has been the case for some considerable time past. For instance, the shipbuilding industry is distinctly more active, some of the Tees-side yards having a year's work in advance, while most of the other centres of this important source of consumption are, fortunately, similarly well situated. But industrial needs generally seem to be broadening out, and although ironmasters are not inclined to indulge in extravagant hopes, they confidently anticipate better times ahead. The new rebates on railway rates have, however, had a rather disturbing effect, since buyers have been inclined to look for concessions which sellers are not disposed to grant. Prices consequently remain firmly fixed, as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

Of late there has been a slight slackening of demand in the market for East Coast hematite, but this may be regarded as due to seasonal causes, while quotations are practically unaltered, No. 1 quality being still at 71s. 6d., with mixed numbers standing at 71s. per ton at furnace. On the North-West Coast prices are steady at 70s. for Bessemer mixed numbers at works.

LANCASHIRE.—As is usually experienced towards the end of the year, business in foundry pig in this area is on a subdued scale, and without noteworthy change in prices, current quotations ruling as follow:—Derbyshire No. 3, 67s. to 67s. 9d.; North Staffordshire, 67s. to 67s. 9d.; with Scotch brands from 87s. to 90s., all delivered locally.

THE MIDLANDS.—Buying, as far as foundry pig is concerned, continues on a restricted scale, and at Birmingham this week there has only been a limited demand from consumers. Prices, however, remain firm at about the following quotations:—Northants No. 3, 55s. 6d. to 56s. 6d.; Derbyshire, 60s.; North Staffordshire No. 3, 60s., all f.o.t. furnaces. Cleveland and Lincolnshire qualities are unchanged at 81s. 9d. and 72s. respectively.

SCOTLAND.—As a significant indication of the state of the Scotch pig-iron trade, it has to be regretfully reported that a prominent firm have taken the drastic step of blowing out all the furnaces they had in operation, namely, five. The firm in question are among the largest producers of pig-iron in Scotland, and it is the first occasion that they have gone to the extreme of putting all their furnaces out, except in the case of labour trouble. At the moment the demand shows no sign of increasing, and founders are only taking their day-to-day requirements.

Finished Iron.

At Birmingham this week the prices for the various grades of bar iron are without any change. Marked bars are in steady demand at £12 at makers' works. The demand for crown and the cheaper grades of iron keeps at a very low level, and the works find competition very severe. Consequently prices remain low, and the mills are quite unable to keep going with any degree of regularity. Crown bars are quoted at between £9 and £9 10s., and nut and bolt iron at £8 12s. 6d. and upwards. Very little business is developing for the latter on account of Belgian competition. No. 3 iron from this source is being offered at cheaper rates, and can now be bought delivered in this district at £7 2s. 6d.

Steel.

Recent developments, as affecting this section of the market, including substantial orders for shipbuilding and steel sleepers and rails for British railway companies, have given some encouragement to the heavy department of the home industry, which had not participated in the later improvement in the demand to the same extent as the lighter branches of the trade. Export transactions have, however, fallen off considerably of late, not only in British material, but also in Continental steel. As a consequence of the reserved attitude of buyers, the prices of several descriptions of Continental steel have become weaker. At Sheffield the trade position shows an improvement in some directions, and more basic furnaces are being put into operation. In the tinplate market home trade buyers are booking fairly well for next year, and paying round 18s. basis f.o.t. at works for usual lines.

Scrap.

Very little variation in conditions is observable in the markets for scrap metals generally, and at Middlesbrough this week only a quiet demand is reported for cast-iron machinery qualities, which are still quoted at 65s., with heavy ordinary at 60s. per ton. In the Midlands, however, there is a fair demand for heavy machinery cast-iron scrap broken into cupola sizes at 65s., with 60s. to 62s. 6d. for medium cast-iron scrap, and 55s. for the lighter qualities, all delivered at works. In Scotland, unfortunately, the cast-iron scrap market shows little or no change, and prices are very poor; it is still difficult to obtain even 65s. for first-quality machinery cast-iron scrap. Ordinary heavy cast-iron quality is at 60s. to 61s., and light cast-iron scrap is 57s. 6d. to 58s. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The situation as regards warrant copper continues much the same as last reported, the market remaining steady, and with few fluctuations of importance in the past week's quotations. At the moment there appear to be no signs of any diminution in the rate of consumption, which, on the whole, is a satisfactory state of affairs. But it must be borne in mind that, if these conditions persist, producers may be faced with a position which will necessitate a further rise in prices in order to regulate supplies. But, on the other hand, anticipatory buying by consumers is likely to become less active.

Closing quotations are :—

Cash.—Thursday, £68 3s. 9d. to £68 5s.; Friday, £68 2s. 6d. to £68 5s.; Monday, £68 1s. 3d. to £68 2s. 6d.; Tuesday, £68 2s. 6d. to £68 3s. 9d.; Wednesday, £68 6s. 3d. to £68 7s. 6d.

Three Months.—Thursday, £68 11s. 3d. to £68 12s. 6d.; Friday, £68 10s. to £68 11s. 3d.; Monday, £68 7s. 6d. to £68 8s. 9d.; Tuesday, £68 8s. 9d. to £68 10s.; Wednesday, £68 11s. 3d. to £68 12s. 6d.

Tin.—A decline of some £8 in tin values at last week's close indicates the effect of the publication of the monthly returns, which again show an excess over the figures of the corresponding period last year. For the time being the powerful support which has been behind the market of late relating to the control of a large portion of the metal held in stock is relaxed, and it is possible that a good deal of liquidation has yet to come forward. The outlook as regards consumption is entirely satisfactory, but it is well to recognise that there is an excess of supplies in existence, which is in itself a factor which certainly does not justify a renewed advance for the present.

Official closing prices :—

Cash.—Thursday, £231 to £231 2s. 6d.; Friday, £227 5s. to £227 10s.; Monday, £225 10s. to £225 15s.; Tuesday, £227 10s. to £228; Wednesday, £225 5s. to £225 7s. 6d.

Three Months.—Thursday, £229 17s. 6d. to £230; Friday, £225 15s. to £226; Monday, £223 10s. to £223 15s.; Tuesday, £225 to £225 5s.; Wednesday, £222 7s. 6d. to £222 10s.

Spelter.—In the market for ordinary spelter the prospect of an impending international agreement has been chiefly responsible for an upward movement of prices. An additional impetus was provided by a subsequent development in the demand. Reports from America indicate that more active conditions in the trade done with consumers has prevailed there recently.

Daily quotations are :—

Ordinary. — Thursday, £26 2s. 6d.; Friday, £26 8s. 9d.; Monday, £26 10s.; Tuesday, £26 12s. 6d.; Wednesday, £26 15s.

Lead.—The recent advance in soft foreign pig has been chiefly due to large Continental buying, although there is no doubt that it was also affected by the rise in spelter values. The home consumption demand, particularly in manufactured products, is quiet, and supplies are plentiful. This consumption, which is normally quiet at this period of the year, cannot be expected to increase during the current month.

Prices have been :—

Soft Foreign Prompt. — Thursday, £21 6s. 3d.; Friday, £21 3s. 9d.; Monday, £21 5s.; Tuesday, £21 2s. 6d.; Wednesday, £21 6s. 3d.

Company Meetings.

Industrial Newspapers, Limited.—At the second annual general meeting of Industrial Newspapers, Limited, held on Thursday, December 6, Sir Arthur Lowes Dickinson, M.A. (chairman), in moving the adoption of the report and accounts, remarked that the results for the fifteen months from July 1, 1927, to September 30, 1928, showed a decided improvement upon those disclosed by the first annual report, and upon this result they might congratulate themselves when they remembered the conditions prevailing in the basic industries, coal in particular, with which one of their principal publications was so intimately associated. Those industries were faced abroad with the keenest competition they had ever known, intensified by the lower standards of living prevailing among the working classes of neighbouring countries. In one country only, *i.e.*, the United States, were these standards higher than their own, and there they were accompanied by far higher standards of production. The remedy lay largely in an increase in production per person employed at least proportionate to the higher standard of living; and one of the elements in achieving this aim was the greater use of machinery. Those communities which were foremost in employing more modern and more efficient machinery would be the most successful in the struggle. It was in that direction that a trade journal could be of real service in disseminating information and giving skilled guidance on the newest processes of manufacture and the machinery being devised therefor, and so could materially assist its *clientèle* of readers and advertisers in modernising and mechanising their industry. This physical and mechanical regeneration was a task which, when fulfilled, would amply reward those engaged upon it, and greater efficiency in methods and means of productivity and in the quest of markets were essential if this country was to regain its ascendancy in the commerce of the world.

The Foundry Trade Journal had this year been honoured by the Paris International Foundry Exhibition through the award of a Grand Prize as an acknowledgment of the service it had rendered for so many years to the industry for which it catered.

Turning to the accounts, and referring to the reorganisation of the capital of the company which had recently taken place, the chairman pointed out that the vendors—with their nominees owning over 80 per cent. of the second preference shares—desired to help the Company in arranging its capitalisation by assuming the burden of the underwriting and preliminary expenses of the Company, and by making a return in respect of the purchase price. It was disappointing that, owing to the delay in obtaining approval of the scheme by the Court, which approval was obtained on November 19, the resolutions having been passed before the end of September, the effect of the reorganisation could not be shown in the official balance sheet; but a *pro formo* balance sheet had been attached to the annual report, incorporating the reorganisation. The short effect was that the second preference shares were reduced from shares of £1 to the same number of shares of 10s., together with 3½ ordinary shares of 1s., and that the interest on the second preference shares was reduced from 7½ per cent. cumulative on £1 to 8 per cent. cumulative on 10s. These reductions had provided a sum of £75,625, of which £58,231 had been applied to the writing-off of underwriting commission and preliminary expenses, whilst the balance of £17,394 had been applied in reduction of the purchase price of newspapers. The other changes in the balance sheet were slight, but satisfactory. Sundry debtors showed a decrease of £9,850, reflecting that the firm's customers had been meeting their accounts more promptly, which it was hoped indicated that trade was improving with them. The cash at bank and in hand showed the satisfactory increase of £6,630, while sundry creditors had been reduced from £16,479 to £11,186. In the profit-and-loss account the gross profit showed an increase of £3,699, and the expenses showed a reduction of £464. Out of the profits of £40,597 for the period of fifteen months income tax had absorbed £7,387, and the full dividend of 7¼ per cent. had been paid on the first preference shares. A dividend had also been paid on the second preference shares at the rate of 7½ per cent. per annum on £220,000 up to December 31, 1927, and at the rate of 4 per cent. for the nine months to September 30 last, equivalent to 8 per cent. per annum on the reduced capital of £110,000. The balance of £2,850 was added to that brought forward from the preceding period, making a total of £10,739 to be carried forward to the next account.

Sir Berkeley Sheffield, Bt., M.P., is to be principal guest at to-morrow's annual dinner of the London Section of the Institute of British Foundrymen, to be held at the Engineers' Club.

Sterling

SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as Standard Box equipment by the majority of the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency.

If you are not a user of Sterling Boxes your competitors have the advantage of you.

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone : 3345 BEDFORD.
Telegrams : "STERFLASK, BEDFORD."
Code WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	68 6 3
Three months	68 11 3
Electrolytic	74 15 0
Tough	72 10 0
Best selected	72 15 0
Sheets	98 0 0
India	83 0 0
Wire bars	75 2 6
Do. December	75 2 6
Do. January	75 2 6
Ingot bars	75 2 6
H.C. Wire rods	79 5 0
Off. av. cash, November	68 2 3 11/17
Do. 3 mths., November	68 10 11 13/23
Do., Sttlmnt., November	68 2 4 11/17
Do., Electro, November	74 19 7 10/11
Do., B.S., November	73 1 4 5/8
Aver. spot price, copper, Nov.	68 2 3 11/17
Do. Wire bars, November	75 4 3 12/17
Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10¼d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11¾d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10⅝d.
Wire	10¾d.
Rolled metal	10½d
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	225 5 0
Three months	222 7 6
English	224 0 0
Bars	228 15 0
Straits	227 12 6
Australian	227 10 0
Eastern	230 5 0
Banca	227 15 0
Off. av. cash, November	232 19 5 2/11
Do., 3 mths., November	228 0 11 13/23
Do., Sttlmt., November	232 18 11 8/11
Aver. spot, November	232 19 5 2/11

SPELTER.

	£ s. d.
Ordinary	26 15 0
Remelted	24 12 6
Hard	20 0 0
Electro 99.9	30 0 0
English	27 0 0
India	21 15 0
Zinc dust (Nom.)	36 10 0
Zinc ashes	8 5 0
Off. aver., November	24 16 3 15/44
Aver., spot, November	24 16 0 5/11

LEAD.

	£ s. d.
Soft foreign ppt.	21 6 3
English	22 10 0
Off. average, November	21 7 0 32/44
Average spot, November	21 4 9 3/11

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	34 10 0
Do. V.M. ex whf.	33 0 0
Rods	42 0 0
Boiler plates	31 0 0
Battery plates	32 10 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	57 10 0
Chinese	39 5 0
Crude	33 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 5 9

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£12 0 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/4½ lb. to 1/5
Tungsten metal powder—	
98/99%	1/10 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 12 6
6/8% car.	£20 10 0
8/10% car.	£20 7 6
Ferro-chrome—	
Max. 2% car.	£33 0 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£44 0 0
70% carbonless	1/- lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£98 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80% export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length, 10% extra.	

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 7 6	to 3 8 6
Bundled steel and shrngs.	3 3 6	to 3 7 6
Mixed iron and steel	3 0 0	to 3 2 6
Heavy cast iron	2 15 0	to 2 17 0
Good machinery for foundries	2 18 0	to 3 0 0
Cleveland—		
Heavy steel	2 18 6	
Steel turnings	2 8 0	
Cast iron borings	2 2 6	
Heavy forge	3 7 6	
Bushelled scrap	2 18 6	
Cast-iron scrap	3 2 6	
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 7 6	
Steel turnings	2 5 0	

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	54 0 0
Brass	39 0 0
Lead (less usual draft)	19 0 0
Tea lead	16 0 0
Zinc	15 10 0
New aluminium cuttings	66 0 0
Braziery copper	50 0 0
Gunmetal	50 0 0
Hollow pewter	150 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	77/6
,, d/d Birm.	85/6
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/6
Derbyshire forge	59/-
,, fdry. No. 3	60/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	63/-
Lincs. forge	63/-
,, fdry. No. 3	65/6
E.C. hematite	81/-
W.C. hematite	82/6
Lincs. (at furnaces)—	
Forge No. 4	58/6
Foundry No. 3	61/-
Basic	60/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	67/6
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	10 5 0	
Nut and bolt iron	8 12 6	to 8 17 6
Hoops	11 10 0	
Marked bars (Staffs.) f.o.t.	12 0 0	
Gas strip	11 10 0	
Bolts and nuts, ½ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.	10 10 0	
Chequer plts.	10 12 6	
Angles	7 17 6	
Tees	8 17 6	
Joists	7 17 6	
Rounds and squares, 3 in. to 5½ in.	8 17 6	
Rounds under 3 in. to ½ in. (Untested)	7 15 0	and upwards
Flats, over 5 in. wide and up	8 7 6	
Flats, 5 in. to 1½ in.	7 17 6	
Rails, heavy	8 10 0	
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	10 0 0	to 10 10 0
Galv.cor.shts..24g.	13 7 6	to 13 12 6
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	6 5 0	to 6 12 6
Billets, hard	7 0 0	to 7 12 6
Sheet bars	6 0 0	
Tin bars	6 0 0	

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2½
Sheet to 10 w.g.	1 3½
Wire	1 4½
Rods	1 3½
Tubes	1 7½
Castings	1 2½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	16.50
Basic	19.76
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens)

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	13/- to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/-
,,	28×20 ,,	36/-
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	14/9
,,	28×20 ,,	33/6
,,	20×10 ,,	21/-
,,	18¾×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars & nailrods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft, steel	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Dec. 6 ..	68	3	9	dec. 1/3
,, 7 ..	68	2	6	,, 1/3
,, 10 ..	68	1	3	,, 1/3
,, 11 ..	68	2	6	inc. 1/3
,, 12 ..	68	6	3	,, 3/9

Electrolytic Copper.

	£	s.	d.	
Dec. 6 ..	74	15	0	No change
,, 7 ..	74	15	0	,, ,,
,, 10 ..	74	15	0	,, ,,
,, 11 ..	74	15	0	,, ,,
,, 12 ..	74	15	0	,, ,,

Standard Tin (cash).

	£	s.	d.		
Dec. 6 ..	231	0	0	dec.	37/6
,, 7 ..	227	5	0	,,	75/-
,, 10 ..	225	10	0	,,	35/-
,, 11 ..	227	10	0	inc.	40/-
,, 12 ..	225	5	0	dec.	45/-

Tin (English ingots).

	£	s.	d.		
Dec. 6 ..	230	5	6	dec.	35/-
,, 7 ..	226	10	0	,,	75/-
,, 10 ..	224	15	0	,,	35/-
,, 11 ..	226	15	0	inc.	40/-
,, 12 ..	224	0	0	dec.	45/-

Zinc Sheets (English).

	£	s.	d.	
Dec. 6 ..	34	10	0	No change
,, 7 ..	34	10	0	,, ,,
,, 10 ..	34	10	0	,, ,,
,, 11 ..	34	10	0	,, ,,
,, 12 ..	34	10	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Dec. 6 ..	26	2	6	inc. 1/3
,, 7 ..	26	8	9	,, 6/3
,, 10 ..	26	10	0	,, 1/3
,, 11 ..	26	12	6	,, 2/6
,, 12 ..	26	15	0	,, 2/6

Lead (English).

	£	s.	d.	
Dec. 6 ..	22	15	0	No change
,, 7 ..	22	10	0	dec. 5/-
,, 10 ..	22	10	0	No change
,, 11 ..	22	10	0	,, ,,
,, 12 ..	22	10	0	,, ,,

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	54 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 6
1927	95 4½	95 6	96 6	95 6	95 3	91 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	—	—

* No prices available.

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